Great Lakes Reconnaissance Surveys Lake Erie Harbours Water and Sediment Quality 1998

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FOREWORD

The Environmental Monitoring and Reporting Branch monitors ambient water quality in the nearshore of the Great Lakes on a cyclical basis. In 1998 the focus of monitoring activities was on the Lake Erie nearshore. Environmental information was collected in the areas of Port Maitland, Port Burwell, Port Bruce, Port Stanley, Port Dover and Nanticoke, Leamington, Wheatley, and the Thames River as part of the Ministry's Great Lakes Nearshore Monitoring and Assessment Program.

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The Lake Erie Harbour Water Quality Monitoring Survey was conducted by the Water Monitoring Section of the Environmental Monitoring and Reporting Branch of the Ontario Ministry of Environment (MOE).

The author would like to acknowledge the assistance of Duncan Boyd and Todd Howell of MOE for their review of the report and assistance with the survey design.

The author would also like to acknowledge the efforts of the crew chief Wendy Page for the field work and further acknowledge the efforts of the Biomaterials and Sediment Unit, Water Chemistry Unit and Dioxin and Furan Unit of the MOE Laboratory Services Branch for the analysis of these samples.

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LAKE ERIE HARBOURS WATER AND SEDIMENT QUALITY, 1998 - SUMMARY

In 1998 the focus of the Water Monitoring Section's monitoring activities was Lake Erie. Environmental information was collected in the areas of Port Maitland, Port Burwell, Port Bruce, Port Stanley, Port Dover and Nanticoke, Leamington, Wheatley, and the Thames River as part of the Great Lakes Nearshore Monitoring and Assessment Program.

The objectives of the 1998 surveys were to:

(a) Determine general nearshore water quality conditions at harbours, embayments, and tributary mouths over a range of potentially degraded and background areas within the Lake Erie drainage basin,

(b) Compare water and sediment quality among these areas, and

(c) Flag locations and water/sediment quality parameters which exceed Provincial Water Quality Objectives and Provincial Sediment Quality Guidelines.

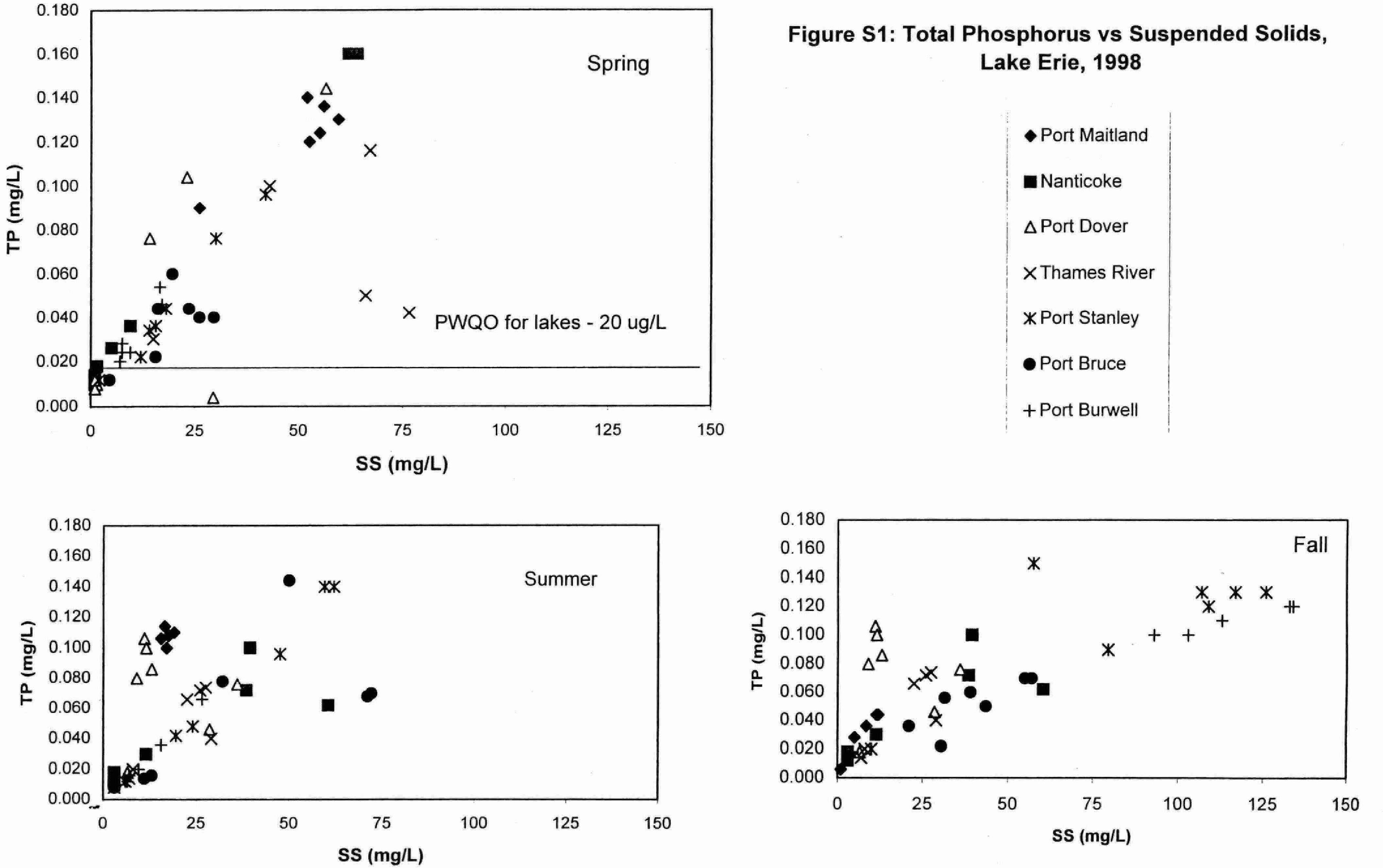
Triplicate surface sediment samples were collected from five or six stations at each survey area in August 1998. Water samples were collected from each station at a single point in time within a season (spring, summer and fall). Accordingly, the water data are an indication of the water quality at the time of sampling only. Lake Erie has a large influence on the nearshore and tributaries, hence changes in the concentration of various parameters in the nearshore area can be significant over a short time due to variations in Lake Erie currents, tributary flow rates and local weather patterns (e.g. precipitation events).

Water Quality in Lake Erie Harbours

In general, water quality in all survey areas was impaired due to high total phosphorus (TP) (greater than the PWQO;20 *ug*/L), nitrogen and suspended solid concentrations at the inner harbour stations and at stations located in the tributaries where eutrophic conditions were present. High nutrient concentrations were likely due to local agricultural practices. The tributaries were also high in chloride concentrations. There was evidence of TP, nitrogen, chloride and solids loadings to the lake from the tributaries in all survey areas emphasizing the impact of the tributary water quality on the nearshore of Lake Erie.

Generally, TP concentrations were highly correlated with suspended solids since water samples were unfiltered and the local sediment was high in phosphorus due in part to loadings from agricultural land practices, surface run-off and due to the natural geology of the basin. The highest concentrations of TP were typically detected in samples collected from Port Maitland, Port Dover and the Thames River. High concentrations of TP in the fall at Port Stanley and Port Burwell were likely due to extremely high concentrations of suspended solids in the water samples (up to 134 mg/L)(Figures S1).

Figure S1: Total Phosphorus vs Suspended Solids, Lake Erie, 1998



Typically the ratio of TIN (total inorganic nitrogen) to TON (total organic nitrogen) was greater than one in the tributaries suggesting higher concentrations of inorganic nitrogen compared with organic nitrogen. Common sources of inorganic nitrogen (which was primarily nitrate in all water samples), are human waste (waste water treatment plants), animal waste and nitrogen rich fertilizers. Overall, concentrations of TIN were consistently high at all tributary stations particularly in the spring. The data identified the tributaries as important sources of nitrogen to the harbours. Concentrations of nitrate in the tributaries ranged from 2.4 to 5.0 mg/L.

Secchi disc depth measurement were low (< 1 m) at most stations within the harbours and tributaries due to the high suspended solids loadings. Port Maitland and the Thames River had the highest concentrations of suspended solids in the spring (Grand River:52 mg/L; Thames River 76 mg/L). In the summer most harbour and tributary stations also had high suspended solid concentrations (between 10 and 40 mg/L), with a few stations ranging as high as 70 mg/L.

In the fall, suspended solids concentrations were extremely high at Port Stanley, Port Burwell and Port Bruce at both the lake stations and outer harbour embayment stations. The data suggested that the lake water was influencing the upstream water quality of the tributaries associated with each harbour, particularly at Port Burwell and Port Stanley. The high suspended solid concentrations at the lake stations were likely due to bank and shoreline erosion following large storm events prior to the sampling dates. This pattern was not apparent in the fall at the other survey areas located in the eastern basin of Lake Erie.

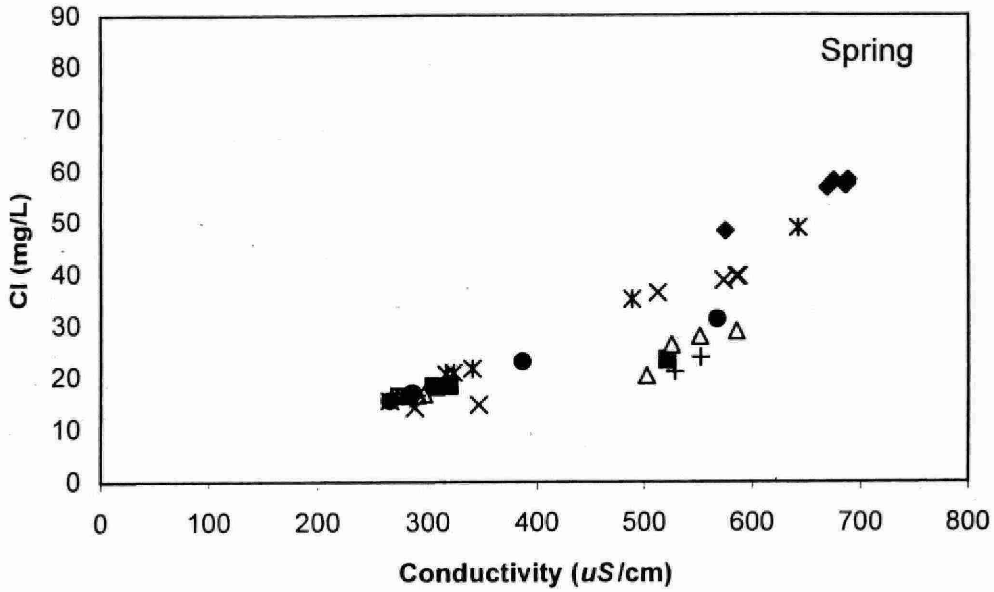
Chloride concentrations in water were highest at Port Maitland when compared with the other study locations, with the highest concentrations in the summer samples rather than the expected peak in the spring (due to snow melt and runoff) (Figures S2). In Port Maitland high Cl concentrations extended out to the lake station which highlighted the impact of the Grand River on the nearshore Lake Erie water quality. Port Dover, Nanticoke and the Thames River also had higher Cl concentrations in water collected in the summer and/or fall at the stations in the tributaries compared with the spring water samples. In contrast the highest chloride concentrations at Port Bruce and Port Stanley were present in the spring while there was no seasonal effect on Cl concentrations in Port Burwell.

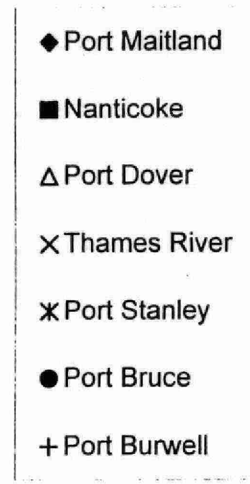
Sediment Quality

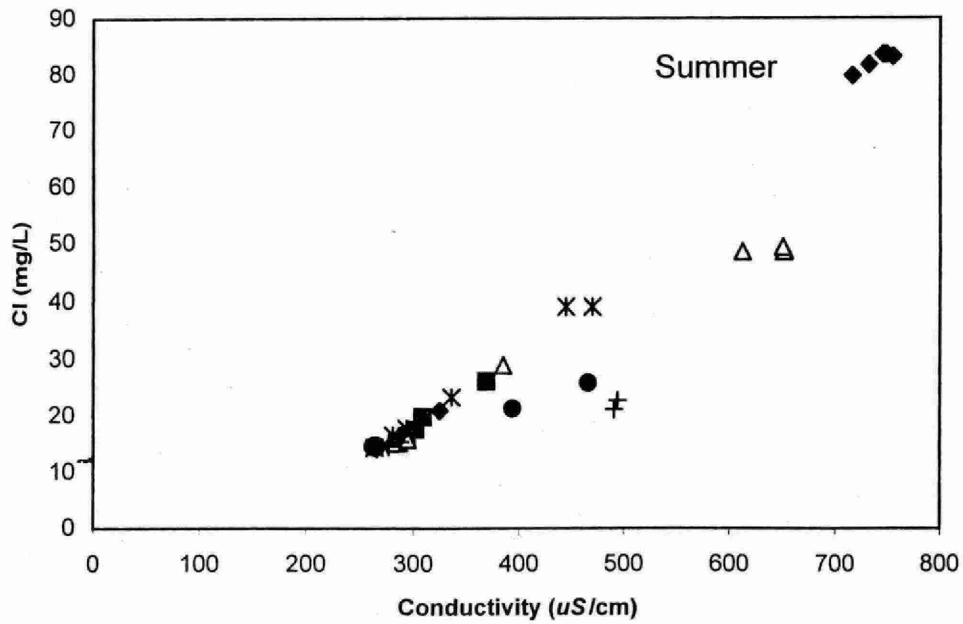
Concentrations of metals, nutrients, p'p-DDE and total PAHs in sediment were greater than the Provincial Sediment Quality Guidelines (PSQGs) Lowest Effect Level (LEL) at some stations in the tributaries and harbours. However, there were no parameters in sediment at concentrations greater than the Severe Effect Level (SEL) with the exception of TP and TKN (total Kjeldahl nitrogen) in sediment collected from Wheatley Harbour.

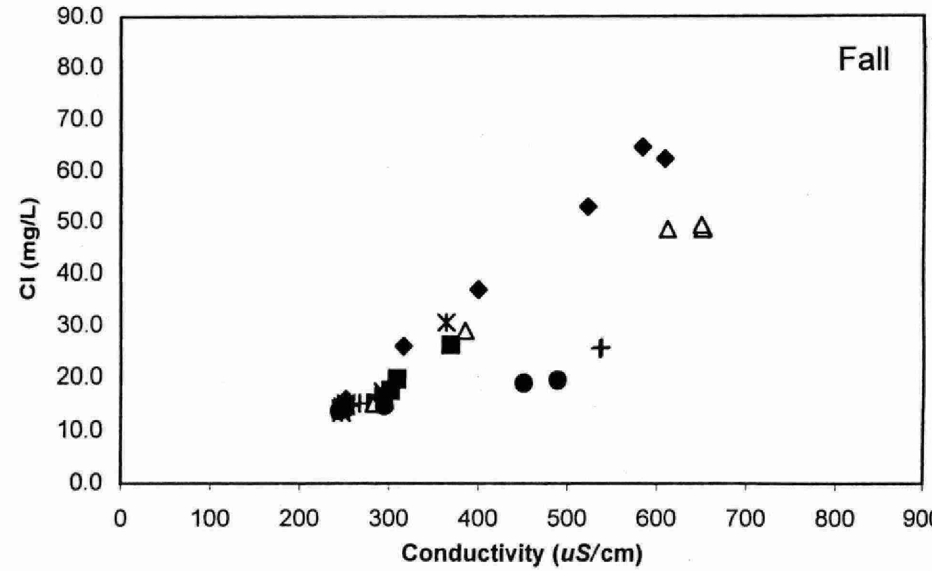
Chlorinated benzenes were not detected in any sediment samples with the exception of trace concentrations of hexachlorobenzene in sediment from Wheatley Harbour and Leamington. Trace concentrations of o'p-DDT, p'p-DDT, α-BHC, β-BHC, γ-BHC and chlordane were

Figure S2: Chloride Concentrations vs Conductivity, Lake Erie, 1998









detected in sediment from selected stations. Total PCBs were detected in one sample from Port Dover and from several stations in Leamington. However, the highest total PCB concentrations were detected in sediment collected from Wheatley Harbour. PAHs were detected at low concentrations in most survey areas.

The highest concentrations of dioxins and furans were present in sediment collected from Wheatley Harbour. The TEQ at two stations in the harbour was 11.2 and 17.8 pg/g compared with TEQs from the remaining harbours that were all less than 4 pg/g. Ontario does not have a Sediment Quality Guideline (SQG) for dioxins and furans at present, however, the interim SQG for the No Effect Level for 2,3,7,8-T4CDD has been set at 25.7 pg/g.

Trends Through Time

The water and sediment quality data from the 1998 survey were compared with data from a Lake Erie harbour survey in June 1991 (Tarandus Associates Limited, 1992). For most parameters, concentrations in water and sediment were similar between the two surveys with only a few exceptions (e.g. TP in water collected from Big Otter Creek (Port Burwell), and conductivity, bacterial counts, TP and nitrite in water collected from Catfish Creek (Port Bruce) were higher in 1992 than in1998). However, due to the limited number of samples collected in both surveys, these differences can not be attributed to changes in water quality over time.

The overall trend towards higher chloride, nutrient and suspended solids concentrations in the tributaries compared to Lake Erie stations was consistent among the harbours and between sampling years. The tributaries were consistently contributing nutrients and suspended solids to the lake and exhibit nutrient enriched conditions as well as high chloride loadings. These results reinforce the importance of nutrient enrichment and suspended solids as issues of concern for Lake Erie water quality.

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BACKGROUND

The Environmental Monitoring Branch monitors ambient water quality in the nearshore of the Great Lakes on a cyclical basis. In 1998 the focus of monitoring activities was on Lake Erie. Environmental information was collected in the areas of Port Maitland, Port Burwell, Port Bruce, Port Stanley, Port Dover and Nanticoke, Leamington, Wheatley, and the Thames River as part of the Great Lakes Nearshore Monitoring and Assessment Program (GLWQM) (Figure 1).

The more extensive data collections were part of the **Great Lakes Reconnaissance Surveys** (GLRS), a two part activity with the purpose of characterizing water quality conditions in the immediate nearshore, the zone most strongly and directly affected by land based activities. The two components of the work are:

(A) <u>*Nearshore Mapping*</u>
A survey design suited to mapping spatial patterns is used to evaluate nutrient, bacteriological, physical and aesthetic features of water quality along selected ranges of shoreline throughout the Great Lakes, and

(B) <u>*Harbour Water Quality Monitoring*</u>
More extensive sampling at a limited number of key sites where water quality conditions are known to be impacted, or, have a potential for impact is used to assess the range of conditions in an area.

The objectives of the 1998 surveys were to:

(a) Determine general nearshore water quality conditions at harbours, embayments, and tributary mouths over a range of potentially degraded and background areas within the Lake Erie drainage basin,

(b) Compare water and sediment quality among these areas, and

(c) Flag locations and water/sediment quality parameters which exceed PWQOs/PSQGs.

A third component of the GLWQM was the **Great Lakes Nearshore Index Station Network**. Data on water and sediment quality and the benthos were collected at seven reference stations in Lake Erie. The purpose of this activity is to provide information on how ambient water quality conditions are changing over time by periodically monitoring a suite of indicators at a small network of stations.

What follows is a summary of results for the *Harbour Water Quality Monitoring* component of the GLRS surveys. The remaining components (Nearshore Mapping and Great Lakes Nearshore Index Station Network) will be reported separately.

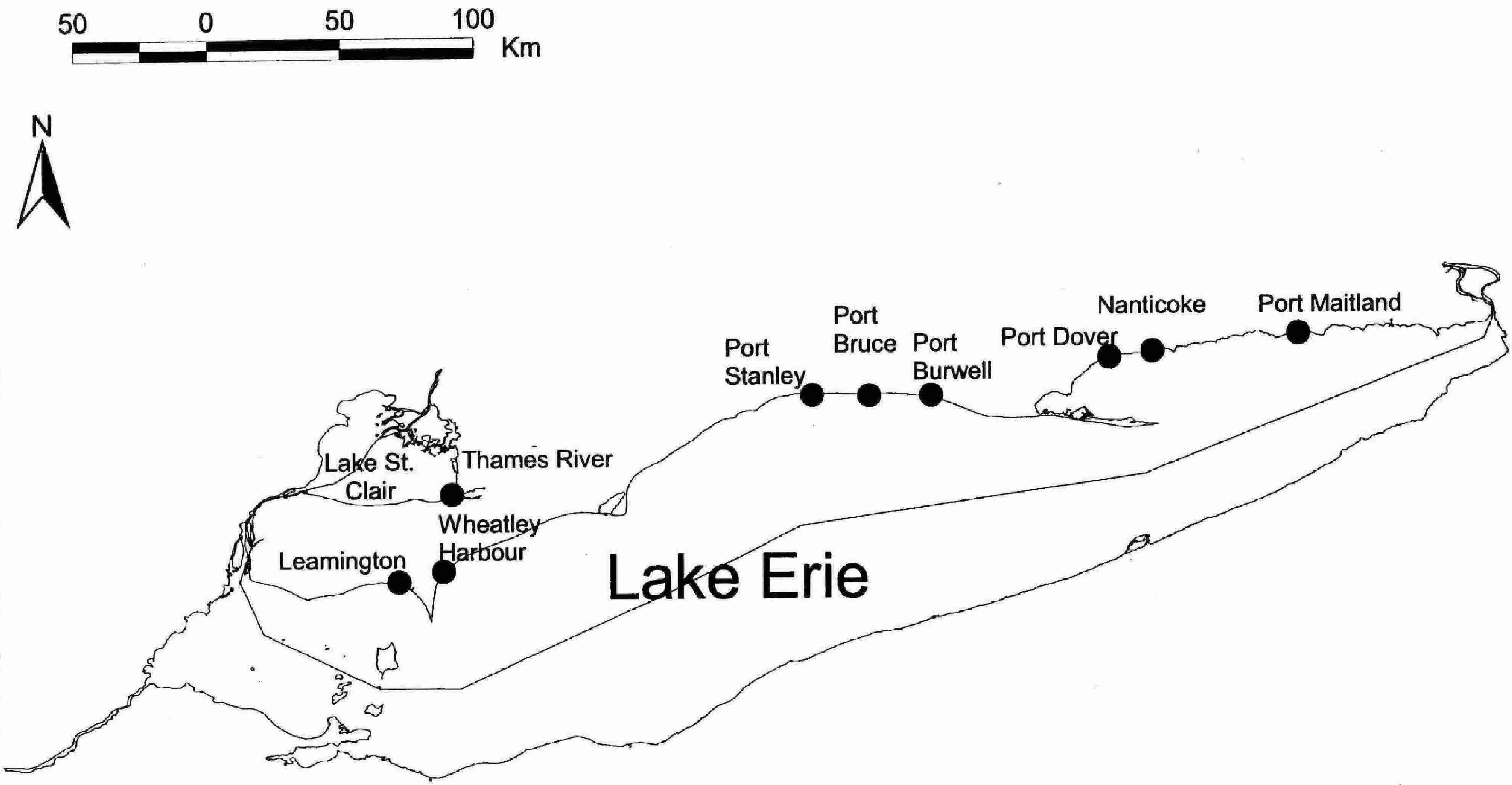


Figure 1: Study Area - Harbour Locations, 1998

METHODS

Water, sediment and benthos were collected from stations located in seven areas in Lake Erie: Port Maitland, Port Burwell, Port Bruce, Port Stanley, Port Dover, Nanticoke and the Thames River, while sediment samples only were collected from two areas: Leamington and Wheatley. The sediment results from the Wheatley survey will augment additional water and sediment sampling from a subsequent 1998 MOE survey of the harbour. Results from both surveys were presented and discussed in the Wheatley Harbour Area Environmental Quality 1998 (Kauss and Bedard November 2001).

Field Methods

Water

Water samples were collected during three surveys (April, August, October) to assess seasonal variation.

During each survey water temperature, field conductivity, field pH and field dissolved oxygen were measured at 1.5 metres below surface at each station. Secchi depth was also measured at all stations.

One whole water grab sample was collected from a depth of 1.5 metres from each station. At one station within each survey area a sample was split for QA/QC to evaluate laboratory analytical precision and variability due to sample handling and collection.

Water samples were collected from a depth of 1.5 m using a March Model 5C MD submersible pump with Teflon® fittings. The tubing was cleaned with distilled water before each days sampling. The sampling line was rinsed with sample water at each station for five minutes prior to sample collection. Water samples collected for bacteria analysis were collected directed into a sample bottle held at 1 m below the surface using a sampling pole. Metal samples were acidified according to the LSB methods manual, mercury samples were acidified and preserved with potassium dichromate. Standard sample containers were used. A distilled blank (field blank) (collected at each sampling area) was poured through the tubing directly into sample containers.

The samples were submitted to the MOE Rexdale laboratory for the following analyses: chloride, ammonia/ammonium, nitrate/nitrite, total kjeldahl nitrogen (TKN), total phosphorus (TP), suspended solids, arsenic, mercury and ICP metals (Al, As, Ba, Be, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sr, Ti, Wu, Zn) and bacteriological analysis.

Sediment

Sediment was collected in August. At each station three replicate grab samples (top 3 cm) were collected using a Shipek grab sampler and submitted for analysis for the following parameters:

Particle size groups, loss on ignition (LOI), total organic carbon (TOC), total phosphorus, total kjeldahl nitrogen, arsenic, mercury, ICP metals, total PCBs (polychlorinated biphenyls), organochlorine pesticides and chlorinated benzenes, polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons and dioxins/furans (one sample per area only).

The top 3 cm was removed from the sampler, homogenized, and distributed into the appropriate containers using stainless steel and Pyrex implements rinsed with distilled water and hexane between samples. A split sample was collected from one station in each study area to evaluate laboratory analytical precision and variability due to sample handling and collection.

Benthos

In addition, triplicate samples were obtained at each of two harbour/embayment locations within each sampling area to be sieved and submitted for benthic macroinvertebrate species identification and enumeration. Results will be provided when the data analysis is completed.

Analytical Methods

All water and sediment samples were analysed at the MOE Rexdale laboratory. All laboratory analytical procedures for contaminants in water and sediment followed the methodology outlined in the Handbook of Analytical Methods for Environmental Samples (MOE 1983).

For water analysis, procedural updates are provided in MOEE (1995d, 1995f to1995i and 1997a to 1997c.). For sediment analysis procedural updates for metals, nutrients, particle size, LOI and TOC analysis are provided in MOE 1989a & b and MOEE 1995a, b & e, 1997d. Procedural updates for total PCBs, (MOEE 1996), organochlorine pesticides and chlorinated benzenes, polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons and dioxins/furans are provided in MOEE 1994a & b and 1995c

Data Interpretation and Analysis

Data tables and figures follow the descriptive text for each survey area.

Since water samples were collected at a single point in time within a season (spring, summer and fall), the data are an indication of the water quality at the time of sampling only. Lake Erie has a large influence on the nearshore and tributaries, hence changes in the concentration of various parameters in the nearshore area can be significant over a short time due to variations in Lake Erie currents, tributary flow rates and local weather patterns (e.g. precipitation events).

Concentrations of contaminants in water and sediment samples were compared with the Provincial Water Quality Objectives (PWQO) and the Ontario Sediment Quality Guidelines (MOEE 1994; Persaud et al. 1992). As well, sediment contaminant data were compared with mean background contaminant concentrations for the Great Lakes basin (pre-colonial horizon)

(Persaud et al. 1992) and for Lake Erie harbours and depositional zones (Mudroch et al. 1988).

The MOE Rexdale laboratory analysed for concentrations of total chromium in the water samples. Comparisons of the Cr data with the PWQOs for Cr VI (1 *ug*/L) and CIII (8.9 *ug*/L) should be made with the caveat that it is unknown whether the concentrations provided for total Cr represent Cr VI or Cr III or some proportion of the two ionic states. Additionally, the PWQO for aluminum (75 *ug*/L) was based on total Al measured in a clay-free sample. Water sample analysed for this survey were on unfiltered samples hence Al concentrations were greatly influenced by the suspended solids concentrations making comparisons with the PWQO difficult (metals data for Al, Cr & Fe are provided in Appendix D).

For bacteria the Ontario Ministry of Health has established a guideline for recreational water quality which is 100 *E. coli* per 100 ml sample based on the geometric mean of the level of *E. Coli* averaged over a minimum of five samples collected within one month (MOEE, 1994). The data from the Harbour Water Quality Surveys was compared with this guideline. However, note that conclusions are based on three rather than five sampling events over seven months.

Total phosphorus (TP) concentrations in water were compared with the PWQO for lakes and/or rivers depending on whether the samples were collected from the open harbour area or the tributary (20 *ug*/L for lakes and 30 *ug*/L for rivers and streams). TIN is defined as total inorganic nitrogen (nitrate plus nitrite plus ammonia/ammonium) and TON is total organic nitrogen (total kjeldahl minus ammonia/ammonium).

The Pearson product-moment correlation was performed using the Excel Tool Pak to examine the relationship among various water quality parameters (nutrients, suspended solids, chloride, conductivity and Al, Fe and Cr). Only the metals that exceeded the PWQOs were included in the correlation analysis. The correlation analysis was performed using values for each station within an area and each sampling event (Appendix C).

Since trace elements tend to accumulate and bind to the clay/silt sediment fraction represented by particle sizes of less than 63 μm (Forstner and Wittmann 1983; Krumgalz et al. 1992), it is necessary to adjust trace element concentrations for the different particle size distributions at the various sampling stations in order to compare contaminant concentrations between stations if the effect of depositional environments are to be diminished and trace metal contaminant sources are to be inferred. The approach taken in this summary was to normalize the anthropogenic trace metal results to a "conservative" element such as aluminum (i.e. an element that is not believed to be locally enriched. The ratio of the other metals to aluminum should remain constant across a gradient of particle sizes unless there is an enrichment of the other metal (Forstner 1990).

RESULTS AND DISCUSSION

PORT MAITLAND

Port Maitland is at the mouth of the Grand River. The Grand River is the largest tributary to Lake Erie with the exception of the Detroit River. The basin area is 6500 km^2. The Grand River watershed is primarily agricultural and extensive wetlands are present along the shoreline particularly near the mouth of the river.

The drainage basin includes the cities of Dunnville, Brantford, Cambridge, Kitchner, Waterloo and Guelph and their associated WPCP discharges and storm sewers. STPs discharging to the river serve about 600,000 people. These urban centers are growing and placing additional pressures on the river and groundwater sources for drinking water supplies. Twelve of the 28 STPs are involved in upgrades or expansions. Discharges impact fish and aquatic life. Rural non point sources were estimated to yield 70 to 90% of the total phosphorus, total suspended solids and bacteria loadings to the river (A. McLarty personal communication).

Industrial activities near the river mouth included the International Minerals and Chemical Fertilizer Production operation which closed in 1984 and was decommissioned. Although treatment systems are still in place and operating to contain leachate from shoreline landfills, phosphorus loadings to the river may still be a concern. The port is used mostly for recreational boating. A marina and yacht club are located along the shores of the river.

Mean daily discharges for the Grand River for 1998 are provided in Appendix A. The range for 1998 was 11 to 459 m^3/sec. Measurements were taken for the Grand River at Brantford (Station ID 02GB001). Flow during the time of sampling was estimated at 108.5 m^3/sec on April 21, 1998 (and was consistently high for about five days prior to sampling), 17.8 m^3/sec on August 27, 1998 and 15.7 m^3/sec on October 27, 1998. Flow measurements were fairly consistent for about two weeks prior to the date of sampling in summer and fall.

Sediment and water were collected from five stations in the Grand River and Port Maitland (Figure 2). The lake station (station 01-1351) was located about 1 km from the harbour mouth and was chosen to determine if the tributary had an effect on lake water quality. Two stations were located in the harbour and two stations were located upstream in the Grand River (station 15-62 and 15-63, downstream of Broad Creek).

All water and sediment data are provided in Tables 1 to 3 and Figure 3 following the description and interpretation of the data for Port Maitland.

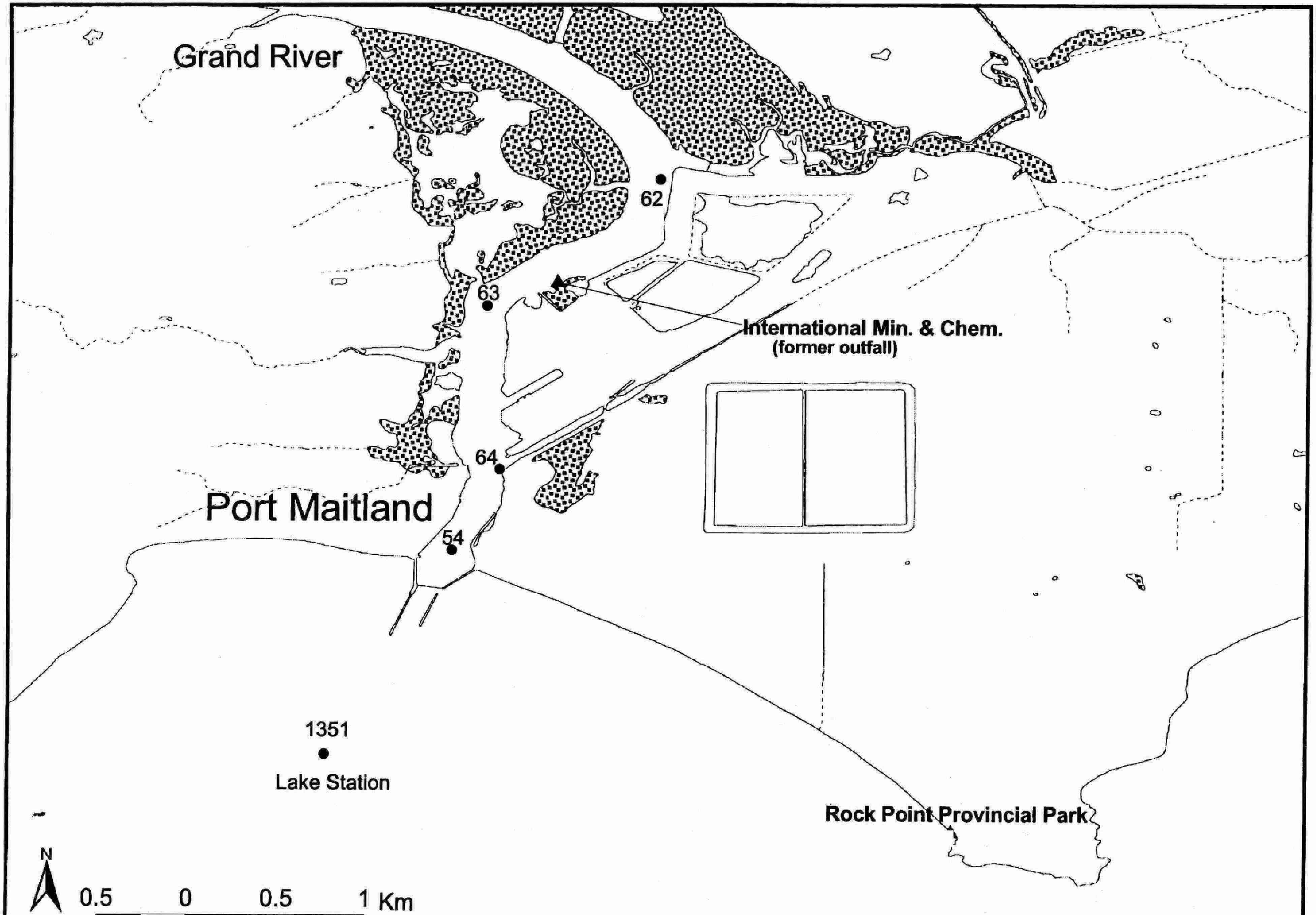


Figure 2: Port Maitland Sampling Stations

Water Quality

Surface water temperature and dissolved oxygen concentrations were consistent between stations for each sampling survey. The temperature ranged from 10.7 to 11.9 °C in the spring, 23.5 to 25.7 °C in the summer and from 12.7 to 13.6 °C in the fall. Dissolved oxygen concentrations were similar in the spring and fall and ranged from 9.9 to 11.5 mg/L. Concentrations were lower in the summer and ranged from 6.9 to10.2 mg/L (Table 1).

Secchi depth readings were low exhibiting poor water clarity in the spring and summer at all stations and ranged from 0.3 to 0.4 m with the exception of the summer measurement (1.9 m) at the lake station (station 01-1351). The secchi depth readings in the fall exhibited a gradient whereby water clarity improved with increasing distance downstream from the Grand River stations towards the Lake Erie station (range: 0.5 to 5.3 m) following the gradient for suspended solids.

Bacteriological Analysis

Bacterial contamination was low in the Grand River and in the harbour of Port Maitland. Only the spring water samples showed bacterial contamination (*Escherichia coli-E. Coli*) that was greater than the provincial guideline for recreational water quality (100 *E. coli*/100mL). High bacterial counts were present only in samples collected from the mouth of the harbour (station 17-54, range: 110 to130 counts/100 mL) and at the Lake Erie station (station 1-1351: 100 counts/100mL). The lowest bacterial counts were upstream in the Grand River at station 15-62. Fecal streptococci counts followed the same pattern as *E. coli.* This pattern of contamination suggested sources of bacteria near the mouth of the harbour.

E. coli levels were below the provincial guideline in the summer and were not detected in the fall samples. Fecal streptococci concentrations were below the detection limit in summer and fall samples while *Pseudomonas aeruginosa* levels were below the detection limit in all water samples collected.

Suspended Solids

Suspended solid concentrations were highest in the spring (likely related to the high flow measurements), and influenced the concentration of other water quality parameters such as phosphorus and trace metals (Figure 3). Suspended solid concentrations were similar in water samples collected from all Grand River and harbour stations during the spring (range: 52.0 to 59.0 mg/L) and summer (range: 15.0 to 19.0 mg/L). The Lake Erie station always had the lowest concentrations (spring: 26.0 mg/L, summer: 3.0 mg/L) which points to the Grand River as the source of suspended solids loadings. A downstream gradient was apparent in the fall with concentrations decreasing gradually from 12.0 mg/L at the upstream station (15-62) to less than 1.0 mg/g at the Lake Erie station.

The high suspended solid concentrations in the spring at the lake station clearly showed the Grand River influence on the nearshore water quality of Lake Erie in the vicinity of the tributary.

Total Phosphorus

Concentrations of total phosphorus (TP) were greater than the PWQO (20 *ug*/L for lakes and 30 *ug*/L for rivers and streams), at all stations in the spring likely due to anthropogenic inputs from land use practices and loadings of solids (Table 1). The highest concentrations were present in water collected from the Grand River (range:120 to 140 *ug*/L). The lowest concentration in the spring was present in water collected from the Lake Erie station (90 *ug*/L) although the phosphorus concentration was still high and clearly influenced by the eutrophic conditions in Port Maitland and the Grand River (Figure 3). The same pattern was present in the summer survey (range:100 to 114 *ug*/L), but concentrations were below the PWQO at the lake station (18 *ug*/L). In the fall, only water collected from the upper Grand River stations had concentrations of TP greater than the PWQO, and a downstream gradient was present following the pattern of suspended solids.

Total phosphorus concentrations in water were strongly correlated with suspended solids ($r=0.82$ $p<0.05$). Since samples were not filtered, this was likely due to the high TP concentration in the sediment which in turn was due to large anthropogenic inputs of phosphorus to the watershed and in part due to the natural geological composition of the basin.

Given the limited number of samples collected in this survey additional inputs from the former International Minerals and Chemical Fertilizer Production operation were not evident in the water and sediment data. Station 15-64 was located in Port Maitland downstream of the facility and adjacent landfills but phosphorus concentrations at this site or at the other downstream sites were similar to the upstream stations in the Grand River. A more detailed sampling grid would be necessary to adequately delineate historical impacts from that facility.

Nitrogen

Consistent with the TP data, water concentrations of TIN (total inorganic nitrogen) and TON (total organic nitrogen) were highest during the spring (Figure 3). Concentrations were similar at all harbour and river stations (range TIN: 2.50 mg/L to 2.63 mg/L; TON:0.93 to 0.98 mg/L) and decreased only slightly at the Lake Erie station (2.14 mg/L and 0.73 mg/L respectively).

Harbour stations had similar TIN concentrations in the summer and fall (range: 0.41 to 0.56 mg/L) while the Grand River stations had higher TIN concentrations in the fall (range:0.73 to 0.80 mg/L), than the summer (range:0.46 to 0.55 mg/L). Higher TIN concentrations in the fall are typical of the nitrogen cycle whereby phytoplankton utilize the available nitrogen in the summer and release it in the fall when the plankton die. Overall, the lowest TIN concentrations were present at the lake station (0.28 and 0.29 mg/L in summer and fall respectively).

High concentrations of TIN (due particularly to high nitrate concentrations in the spring and fall) suggest local inputs of nitrogen from agricultural practices and the extensive wetlands in the area. Runoff from fertilizer applications and cattle grazing typically contribute high nitrate loads. In the summer, concentrations of ammonia/ammonium were also elevated (similar to nitrate concentrations) although concentrations were lower than the PWQO for unionized ammonia (20 *u*g/L).

Chloride and Conductivity

Spring chloride concentrations in water samples were high at all stations (range: 48 to 58 mg/L). High chloride was not surprising in the spring due to runoff from snow melt which is typically high in chloride because of the use of road salt. However, the highest chloride concentrations in water were present in the summer at stations within the harbour and Grand River (range: 79 to 83 mg/L) (Figure 3). Concentrations were similar at all stations with the exception of the lake station (1-1351) which had the lowest chloride concentration (21 mg/L), although this value was high relative to other lake stations sampled in the Lake Erie survey. The fall water samples exhibited a downstream gradient with concentrations as high as 62 mg/L in the Grand River and as low as 16 mg/L at the lake station.

Reduced flow in the summer (about one third of the spring flow), may have contributed to the high Cl concentration. However, Cl was not consistently high in the fall at all stations even though the flow during the fall survey was the same as during the summer survey. As well, the seasonal changes in flow were consistent at all survey areas but summer peaks in Cl were only present in samples collected from Maitland, Port Dover and Nanticoke.

Ambient conductivity measurement followed the same pattern as Cl concentrations. Conductivity was highest in the summer (range: 325 to 775 *u*S/cm) compared with the spring (range: 575 to 688 *u*S/cm) and fall (range: 252 to 609 *u*S/cm). Ambient field values compared favourably with laboratory values collected at selected stations for comparison. Conductivity was high at Port Maitland and Port Dover compared with the other harbours sampled.

Trace Metals

Concentrations of metals were low in the Grand River and Port Maitland. Aluminum and iron were the only metals to exceed the PWQO (75 *u*g/L and 300 *u*g/L respectively). Aluminum concentrations were greater than the PWQO at all stations in the spring and summer surveys with the exception of the lake station in the summer. Iron exceeded the PWQO at all stations in the spring survey. Concentrations of Al and Fe were strongly correlated with suspended solids ($r=0.99$; $r=0.98$ respectively), which influenced the high metal concentrations. The PWQO is based on a clay free sample while samples analysed in this survey were not filtered. Chromium concentrations were greater than the PWQO (Cr VI - 1 *u*g/L; Cr III - 8.9 *u*g/L) in the fall although concentrations were not correlated with suspended solids. However, these values should be interpreted with caution since concentrations were described as trace.

Sediment Quality

Sediment Physical Qualities

The Port Maitland lake station was high in percent sand (>90%) and low in TOC and LOI. These characteristics influenced the concentration of contaminants associated with the sediment. The station located near the mouth of the harbour (station 17-54) and the two upstream stations in the Grand River were all characterized as silty/clay with the highest TOC concentrations in the survey area and high LOI. One harbour station (station 15-64) was characterized as silty sand (sand content ranged from 38 to 43%). TOC was highly correlated with particle size ($r= 0.95$ $p<0.05$).

Metals and Nutrients

Arsenic, Cd, Hg and Pb were below the LEL in sediment samples collected from every station, while Cd was present at either trace concentrations or below the reportable value (Table 2). Concentrations of all parameters were lowest in sediment collected from the lake station due to the extremely high sand content of that sample. Accordingly, only a single replicate was collected at that station.

The highest concentrations of all metals and nutrients were present at stations 15-62, 15-63 and 17-54. Concentrations of Cr, Cu, Fe, Mn, Ni and Zn were greater than the LEL at all three stations. The highest concentrations were present at station 15-62 and then decreased with increasing distance downstream, although concentrations among the three stations were similar. TKN and TP concentrations were above the LEL in sediment collected from all stations in the study area. However, the highest concentrations were also present at stations 15-62,15-63 and 17-54. TOC concentrations and percent fine particles likely influenced sediment contaminant concentrations.

Data were normalized to Al to determine if these patterns were governed by particles size. Ratios were generally similar between stations for most parameters indicating that patterns of enrichment were not discovered.

Concentrations of metals greater than the LEL were compared with the mean background values for the Great Lakes (the pre-colonial sediment horizon) (Persaud et al. 1992) and background values for Lake Erie (Murdroch et al. 1988). Dependant on which values were used as background, Ni and Fe concentrations in the Grand River sediment were less than the background values for most stations while Cu and Cr concentrations minimally exceeded the values presented by Persaud et al.(1992) but were within the range provided by Mudroch et al. (1988) as were Zn concentrations. Zinc concentrations were two times greater than background concentrations proposed by Persaud et al. (1992) and Mn also showed enrichment relative to the pre-colonial concentrations.

Organochlorine Pesticides and Chlorinated Benzenes

Organochlorine pesticides and chlorinated benzenes were not detected in any sediment samples with the exception of trace concentrations of DDE in selected sampled at stations 17-54, 15-62 and 15-63 (Table 2).

Polycyclic Aromatic Hydrocarbons (PAHs)

Low concentrations of PAH compounds were detected at all stations sampled in Port Maitland and the Grand River with the exception of the lake station where PAHs were not detected in any samples. Sediment concentrations of total PAHs at all stations were all less than the LEL (4 *u*g/g) (Table 3).

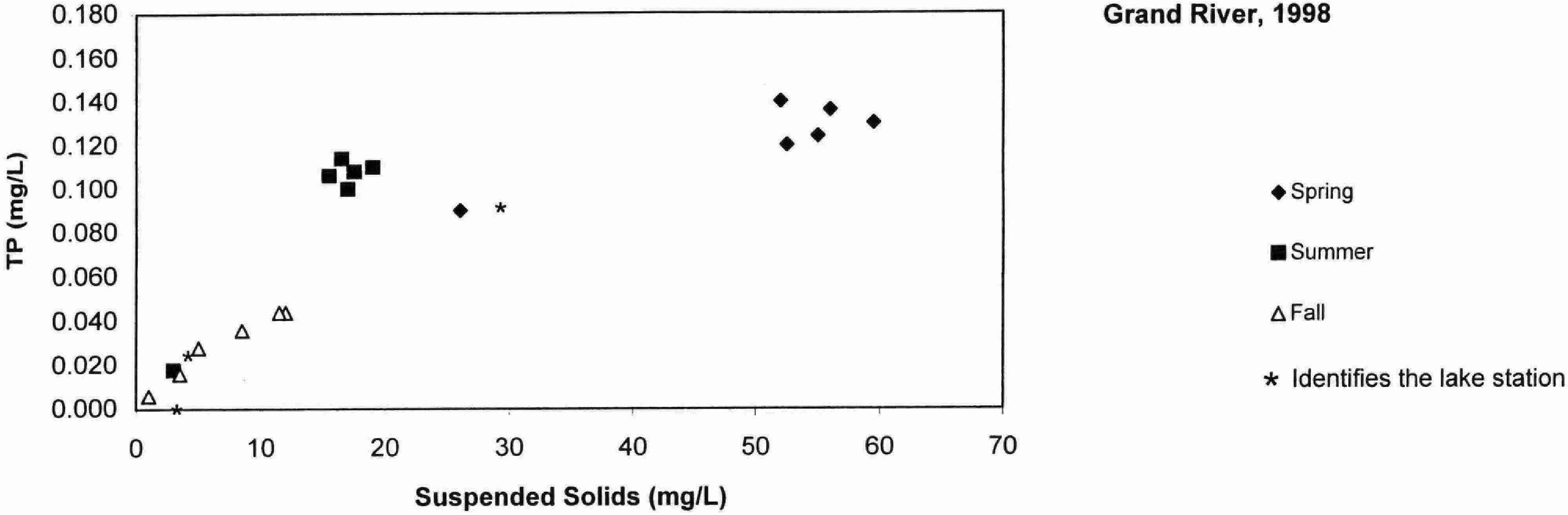
Pyrene, benzo(b)fluoranthene, benzo(b/k)fluoranthene, chrysene, phenanthrene, and fluoranthene were detected at trace concentrations in sediment collected from all harbour and river stations. In addition to the compounds described above, several other parameters were detected in one replicate from stations 17-54 and 15-64. The data from these samples were considered suspect since the contaminant concentrations greatly exceeded the other two replicates from each station and the additional parameters were only present in the single replicates.

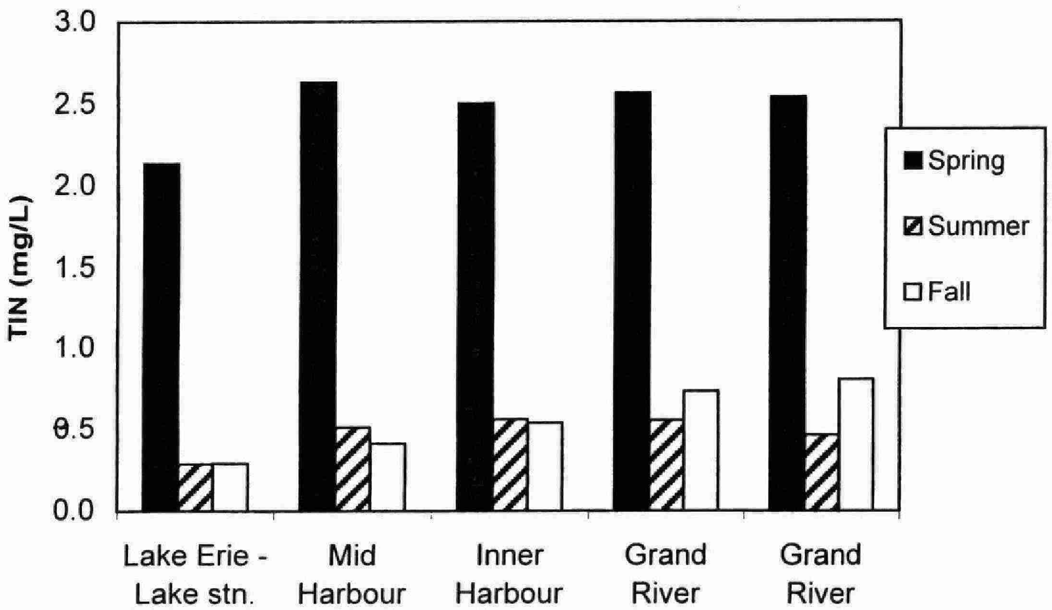
Table 1: Concentration of nutrients, conventional parameters and bacteria in water collected from Port Maitland, 1998

Station Description	Station number			Date YYYYMMDD	Water Depth (m.)	Sample Depth (m.)	Secchi Depth (m)	Water Temp. °C	DO (field) mg/L as O	Conductivity (field) uS/cm 25 C	pH	pH (Field)	*E. coli* count/100mL	RMK	Fecal Streptococci count/100mL	RMK	*Pseudomonas aeruginosa* count/100mL	RMK	Chloride mg/L	RMK	Ammonia/ ammonium mg/L	RMK	Nitrite mg/L	RMK	Nitrite/Nitrate mg/L	RMK	Total Inorganic Nitrogen	TKN mg/L	RMK	Total Organic Nitrogen	Total Phosphorus mg/L	RMK	Suspended Solids mg/L	R
Spring																																		
Port Maitland-Lake Erie	16	1	1351	19980421	8.2	1.5	0.3	10.7	10.4	575		8.10	100		60	<=>	4	<	48.2		0.026		0.037		2.110		2.136	0.76		0.73	0.090		26.0	
Port Maitland-Harbour	16	17	54	19980421	8.5	1.5	0.3	11.8	10.0	687		8.05	130		100		4	<	57.4		0.034		0.055		2.600		2.634	1.00		0.97	0.130		59.5	
Split	16	17	54	19980421	8.5	1.5	0.3	11.8	9.9	688		8.05	110		40	<=>	4		58.2		0.032		0.056		2.500		2.532	0.96		0.93	0.136		56.0	
Port Maitland-Grand River	16	15	64	19980421	3.9	1.5	0.3	11.9	10.2	686		8.07	90	<=>	30	<=>	4	<	57.0		0.024		0.053		2.480		2.504	1.00		0.98	0.140		52.0	
Port Maitland-Grand River	16	15	63	19980421	8.0	1.5	0.4	11.6	10.2	675		8.09	27	<=>	10	<=>	4	<	58.0		0.028		0.059		2.540		2.568	0.96		0.93	0.124		55.0	
Port Maitland-Grand River	16	15	62	19980421	5.2	1.5	0.3	11.7	10.5	669		8.11	10	<=>	10	<=>	4		56.6		0.022		0.059		2.520		2.542	0.96		0.94	0.120		52.5	
Summer																																		
Port Maitland-Lake Erie	16	1	1351	19980827	7.6	1.5	1.9	23.5	7.9	325			4		4	<	2	<	21.0		0.040		0.007		0.245		0.285	0.32		0.28	0.018		3.0	
Port Maitland-Harbour	16	17	54	19980827	7.8	1.5	0.4	24.8	7.6	716			50	<=>	10	<=>	4	<	79.8		0.186		0.023		0.325		0.511	1.04		0.85	0.114		16.5	
Port Maitland-Grand River	16	15	64	19980827	4.5	1.5	0.3	25.7	10.2	732			50	<=>	10	<	4	<	81.8		0.274		0.024		0.285		0.559	1.06		0.79	0.106		15.5	
Port Maitland-Grand River	16	15	63	19980827	6.3	1.5	0.3	24.7	8.3	749			60	<=>	10	<	4	<	83.6		0.224		0.029		0.330		0.554	1.08		0.86	0.108		17.5	
Split	16	15	63	19980827	6.3	1.5	0.3	24.9	8.5	746			50	<=>	10	<=>	4	<	83.6		0.222		0.027		0.330		0.552	1.04		0.82	0.100		17.0	
Port Maitland-Grand River	16	15	62	19980827	6.9	1.5	0.3	24.4	6.9	755	8.48		10	<=>	10	<	4	<	83.2		0.276		0.024		0.185		0.461	1.10		0.82	0.110		19.0	
Fall																																		
Port Maitland-Lake Erie	16	1	1351	19981027	7.2	1.5	5.3	13.6	10.1	252		8.07	4	<	4	<	2	<	16.0		0.004	<T	0.008		0.285		0.289	0.24		0.24	0.006	<T	1.0	<
Port Maitland-Harbour	16	17	54	19981027	7.7	1.5	2.0	13.2	10.3	316		8.12	4	<	4		2	<	26.0		0.002	<=W	0.009		0.410		0.412	0.28		0.28	0.016		3.5	
Port Maitland-Grand River	16	15	64	19981027	4.1	1.5	1.7	13.0	10.6	400		8.20	4	<	4		2	<	37.0		0.002	<=W	0.011		0.535		0.537	0.36		0.36	0.028		5.0	
Port Maitland-Grand River	16	15	63	19981027	6.9	1.5	0.8	12.7	11.0	523		8.23	4	<	4	<	2	<	53.0		0.002	<=W	0.017		0.730		0.732	0.48		0.48	0.036		8.5	
Port Maitland-Grand River	16	15	62	19981027	3.5	1.5	0.5	13.1	11.3	609		8.30	4	<	8		2	<	62.4		0.002	<=W	0.018		0.800		0.802	0.56		0.56	0.044		12.0	
Split	16	15	62	19981027	3.5	1.5	0.5	13.0	11.5	584		8.35	4		4	<	2	<	64.6		0.002	<=W	0.017		0.795		0.797	0.58		0.58	0.044		11.5	
Port Maitland-Grand River (F- blank)				19980421															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.02	<=W	0.02	0.004	<T	0.5	<
Port Maitland-Grand River (F- blank)				19980827															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.02	<=W	0.02	0.004	<T	0.5	<
Port Maitland-Grand River (T- blank)				19980824															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.02	<=W	0.02	0.002	<=W	0.5	<

<W no measurable response
<T measurable trace amount, interpret with caution
<=> approximate value
F-blank field blank
T-blank travel blank

Figure 3: Water quality parameters in surface grab samples - Port Maitland and the Grand River, 1998





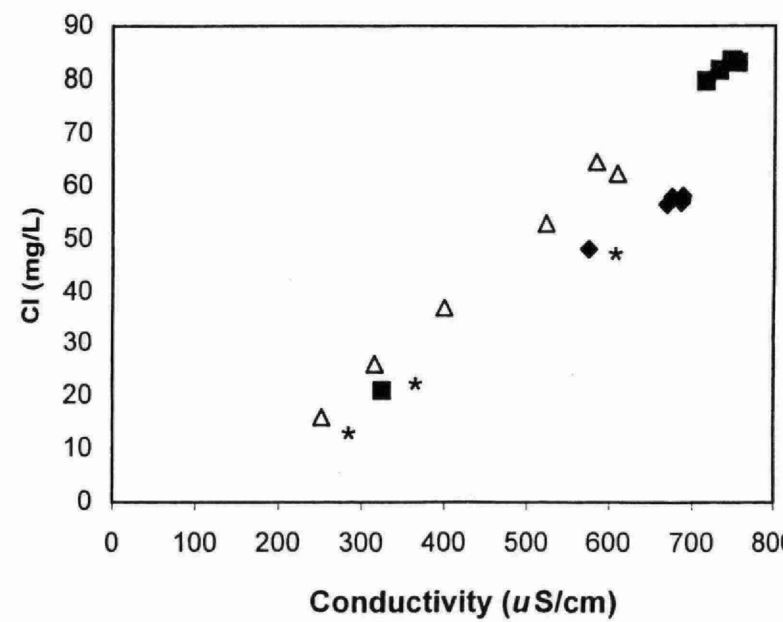


Table 2: Concentrations of nutrients, conventional parameters, metals and p'p-DDE in sediment collected from Port Maitland, 1998

Station Description	Station Number		Date YYYYMMDD	Sample Depth (m)	Aluminum ug/g	Arsenic ug/g	RMK	Cadmium ug/g	RMK	Chromium ug/g	Copper ug/g	RMK	Iron ug/g	Mercury ug/g	RMK
Port Maitland-Lake Erie	1	1351	19980827	7.6	2900	1.0		0.2	<=W	13	1	<=W	11000	0.02	<T
	1	1351	19980827	7.6	3000	1.0		0.2	<=W	9	2	<T	9200	0.02	<T
	1	1351	19980827	7.6	2700	0.9	<T	0.2	<=W	21	1	<=W	9000	0.02	<T
Port Maitland-Harbour	17	54	19980827	7.8	17000	3.2		0.5	<T	41	26		23000	0.06	
	17	54	19980827	7.8	16000	3.2		0.4	<T	29	25		22000	0.05	
split	17	54	19980827	7.8	18000	3.3		0.5	<T	29	27		23000	0.05	
split	17	54	19980827	7.8	17000	3.3		0.6	<T	29	26		23000	0.05	
Port Maitland-Grand River	15	64	19980827	4.7	9000	2.1		0.2	<=W	17	15		12000	0.04	<T
	15	64	19980827	4.2	9300	2.0		0.3	<T	16	15		12000	0.05	
	15	64	19980827	4.3	8700	2.1		0.2	<=W	20	14		12000	0.04	<T
Port Maitland-Grand River	15	63	19980827	7.2	16000	3.1		0.2	<=W	25	23		20000	0.05	
	15	63	19980827	7.1	15000	3.5		0.3	<T	29	23		21000	0.05	
	15	63	19980827	7.0	17000	3.4		0.2	<=W	38	26		22000	0.05	
Port Maitland-Grand River	15	62	19980827	7.0	21000	3.7		0.4	<T	33	31		26000	0.07	
	15	62	19980827	7.0	22000	3.6		0.5	<T	33	31		26000	0.06	
	15	62	19980827	7.0	19000	3.5		0.4	<T	31	30		25000	0.06	
Lowest Effect Level (ug/g)						6		0.6		26	16		20000	0.2	
Severe Effect Level (ug/g) **						33		10		110	110		40000	2	
Background - Great Lakes pre-colonial sediment horizon, Persaud et al. (1992)						4.2		1.1		31	25		31000	0.1	
Background - Lake Erie pre-colonial sediment horizon for Harbours (H) and/or depositional zones (D), Mudroch et al. (1988)						0.5-1.2 (H)		0.1 (H) 0.1-1.7(D)		30-250(H) 9-25(D)	10-110(H) 20-48(D)		1000-15000(H) 8900-48200(D)	0.05-7(H)	

Station Description	Station Number		Manganese ug/g	Nickel ug/g	Lead ug/g	RMK	Zinc ug/g	RMK	TKN mg/g	RMK	Total Phosphorus mg/g	Loss on Ignition (mg/g)	TOC (mg/g)	RMK	Clay %	RMK	Silt %	RMK	Sand %	RMK
Port Maitland-Lake Erie	1	1351	280	4.5	4	<T	27		0.1	<=W	0.5	5.9	2	<T	1	<T	2	<T	97	
	1	1351	260	3.2	3	<T	29		0.1	<=W	0.6	8.9	1	<=W	2		5		93	
	1	1351	260	12	2	<=W	20	<T	0.1	<=W	0.4	5.9	1	<=W	0	<T	2	<T	98	
Port Maitland-Harbour	17	54	650	23	18		140		2.4		1.1	64	25		28		58		15	
	17	54	640	19	18		130		1.6		0.9	63	30		29		58		13	
split	17	54	690	20	18		140		2.0		0.8	67	24		31		63		6	
split	17	54	680	19	19		140		2.1		0.9	64	24		30		61		9	
Port Maitland-Grand River	15	64	400	11	10		89		0.9		0.7	40	18		16		44		40	
	15	64	410	10	13		87		1.0		0.7	40	14		17		45		38	
	15	64	390	12	9	<T	84		0.7		0.8	40	21		15		42		43	
Port Maitland-Grand River	15	63	650	17	15		120		2.1		0.9	75	32		26		64		9	
	15	63	670	21	13		120		1.7		0.8	71	29		27		65		8	
	15	63	690	21	13		140		2.4		1.0	76	32		27		63		11	
Port Maitland-Grand River	15	62	760	24	18		180		3.1		1.0	87	38		31		62		7	
	15	62	770	23	20		160		2.7		1.1	91	38		34		66		1	<=W
	15	62	740	23	17		160		2.7		1.0	90	34		32		64		4	<T
Lowest Effect Level (ug/g)			460	16	31		120		0.55 mg/g		0.6 mg/g		10 mg/g							
Severe Effect Level (ug/g) **			1100	75	250		820		4.8 mg/g		2.0 mg/g		100 mg/g							
Background - Great Lakes pre-colonial sediment horizon, Persaud et al. (1992)			400	31	23		65													
Background - Lake Erie pre-colonial sediment horizon for Harbours (H) and/or depositional zones (D), Mudroch et al. (1988)				55-65(H) 10-76(D)	21-49(D)		40-500(H) 8-128(D)													

<W no measurable response
<T measurable trace amount, interpret with caution
<=> approximate value

Station Description	Station Number		p'p-DDE ng/g	RMK
Port Maitland-Harbour	17	54	3	<T
	17	54	3	<T
Port Maitland-Grand River	15	64	2	<T
Port Maitland-Grand River	15	63	3	<T
Port Maitland-Grand River	15	62	2	<T
	15	62	3	<T
Lowest Effect Level (ng/g)			5	

Table 3: Concentrations of polycyclic aromatic hydrocarbons (ng/g) in sediment collected from Port Maitland, 1998

Station Description	Station Number	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b) fluoranthene	Benzo(k) fluoranthene	Chrysene	Dibenzo(ah) anthracene
Port Maitland-Lake Erie	1 1351	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	1 1351	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	1 1351	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Port Maitland-Harbour	17 54	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	40 <T	40 <T	40 <=W
	17 54	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	40 <T	40 <T	40 <=W
split	17 54	20 <=W	20 <=W	80 <T	200	200	180	160	200	40 <=W
split	17 54	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	40 <T	40 <T	40 <=W
Port Maitland-Grand River	15 64	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	40 <T	40 <T	40 <=W
	15 64	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	40 <T	40 <T	40 <=W
	15 64	20 <=W	20 <=W	60 <T	180	120 <T	100	120	180	40 <=W
Port Maitland-Grand River	15 63	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	40 <T	40 <T	40 <=W
	15 63	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	40 <T	40 <T	40 <=W
	15 63	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	40 <T	40 <T	40 <=W
Port Maitland-Grand River	15 62	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	60 <T	40 <T	40 <T	40 <=W
	15 62	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	40 <T	40 <T	40 <=W
	15 62	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	40 <T	40 <T	40 <=W
Lowest Effect Level (ng/g)				**220**	**320**	**370**		**240**	**340**	**60**

Station Description	Station Number	Fluoranthene	Fluorene	Benzo(g,h,I) perylene	Indeno(1,2,3-cd) pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH
Port Maitland-Lake Erie	1 1351	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	1 1351	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	1 1351	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Port Maitland-Harbour	17 54	100	40 <T	40 <=W	40 <=W	20 <=W	40 <T	80 <T	380
	17 54	100	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	80 <T	340
split	17 54	600	40 <T	120 <T	200	20 <=W	360	460	2800
split	17 54	100	40 <T	40 <=W	40 <=W	20 <=W	40 <T	80 <T	380
Port Maitland-Grand River	15 64	80 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	60 <T	300
	15 64	100	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	80 <T	340
	15 64	400	20 <=W	80 <T	120 <T	20 <=W	200	340	1900
Port Maitland-Grand River	15 63	80 <T	40 <T	40 <=W	40 <=W	20 <=W	20 <=W	60 <T	300
	15 63	80 <T	40 <T	40 <=W	40 <=W	20 <=W	20 <=W	60 <T	300
	15 63	80 <T	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	60 <T	260
Port Maitland-Grand River	15 62	100	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	80 <T	320
	15 62	80 <T	40 <T	40 <=W	40 <=W	20 <=W	20 <=W	80 <T	320
	15 62	100	40 <T	40 <=W	40 <=W	20 <=W	20 <=W	80 <T	340
Lowest Effect Level (ng/g)		**750**	**190**	**170**	**200**		**560**	**490**	**4000**
						Severe Effect Level (ng/g organic carbon)			10,000

<W no measurable response

<T measurable trace amount, interpret with caution

PORT DOVER AND NANTICOKE

Samples were collected from six stations in Port Dover (Figure 4). Stations were located in Black Creek, the Lynn River and at the mouth of the harbour. One station was located near the water pollution control plant (WPCP) (station 01-1364), east of the harbour and a lake station was positioned about 450 m south of the harbour mouth (station 01-1358). Water and sediment samples were collected from all stations with the exception of the station near the WPCP where only water was collected. An additional station was added for sediment sampling at the ship storage area (station 16-2) in the Lynn River where the impact of historical activities (sand blasting, ship painting etc.) were investigated.

The population of Port Dover is approximately 5,500. Small industries (fish processing plant and ship building), operated in the vicinity of the harbour but have subsequently closed in the early and mid 1990's respectively. There are several marinas, farming operations, trailer parks, campgrounds and tourist operations in the surrounding area. The harbour receives storm water from the town of Port Dover and sewage bypass from the WPCP. The harbour is used mainly for recreational boating although commercial fishing vessels also dock their boats at the local marinas. The town water intake plant is located in Lake Erie to the west of the harbour.

The Lynn River and Black Creek are small tributaries which join upstream of the harbour. They both flow through rural land used primarily for crop and animal farming. The Trent Valley Quarry discharges to a creek which flows into Black Creek about 4 km upstream of the harbour. The Lynn River flows through the town of Simcoe (population about 15,000) about 16 km upstream of Port Dover and receives storm water and effluent from the Simcoe STP. Mean daily discharges for the Lynn river are provided in Appendix A and ranged from 1.7 to 15.9 m^3/sec for 1998. The Lynn River gauging station was located in Simcoe (ID 02GC008). During sample collection on April 22, the flow was 6.2 m^3/sec, on August 5 the flow was1.9 m^3/sec, and on October 28, 1998 it was 2.0 m^3/sec. Flow was fairly consistent for several weeks prior to each survey.

Samples were collected from six stations (Figure 5) in the Nanticoke area. Stations were located near the Ontario Power Generation (formerly Ontario Hydro) effluent outfall (01-1362) (coal fired thermal electric plant), the Imperial Oil (Esso) outfall (01-1365) and near the mouth of Centre Creek (01-1359). Most of the flow from Centre Creek was treated effluent and storm water from the Lake Erie Steel Company (approximate average of 5000 m^3/day from Lake Erie Steel and about 10% to 20% additional flow upstream during the wet season). The effluent discharged to the creek is monitored through the provincial MISA program (Municipal Industrial Strategy for Abatement). As well, two sewage lagoons from the Lake Erie Industrial Park and Lake Erie Steel Company discharged to Centre Creek in the spring and fall.

One station was located at the mouth of Nanticoke Creek and two stations were located to the east and west of the creek mouth. Residential homes are located along the bank of Lake Erie to the east and west of Nanticoke Creek. Nanticoke Creek flows through mostly agricultural land.

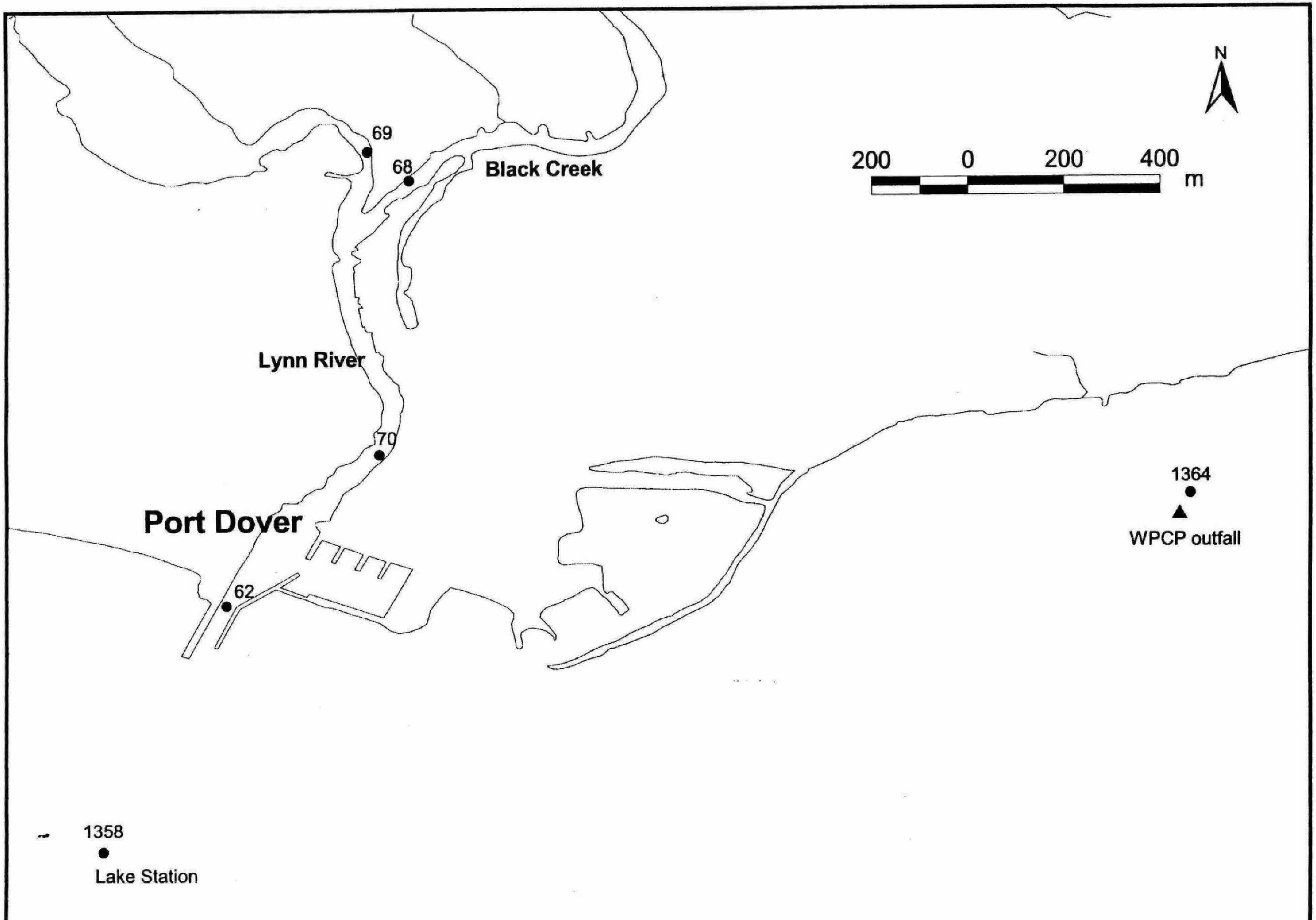


Figure 4: Port Dover Sampling Stations

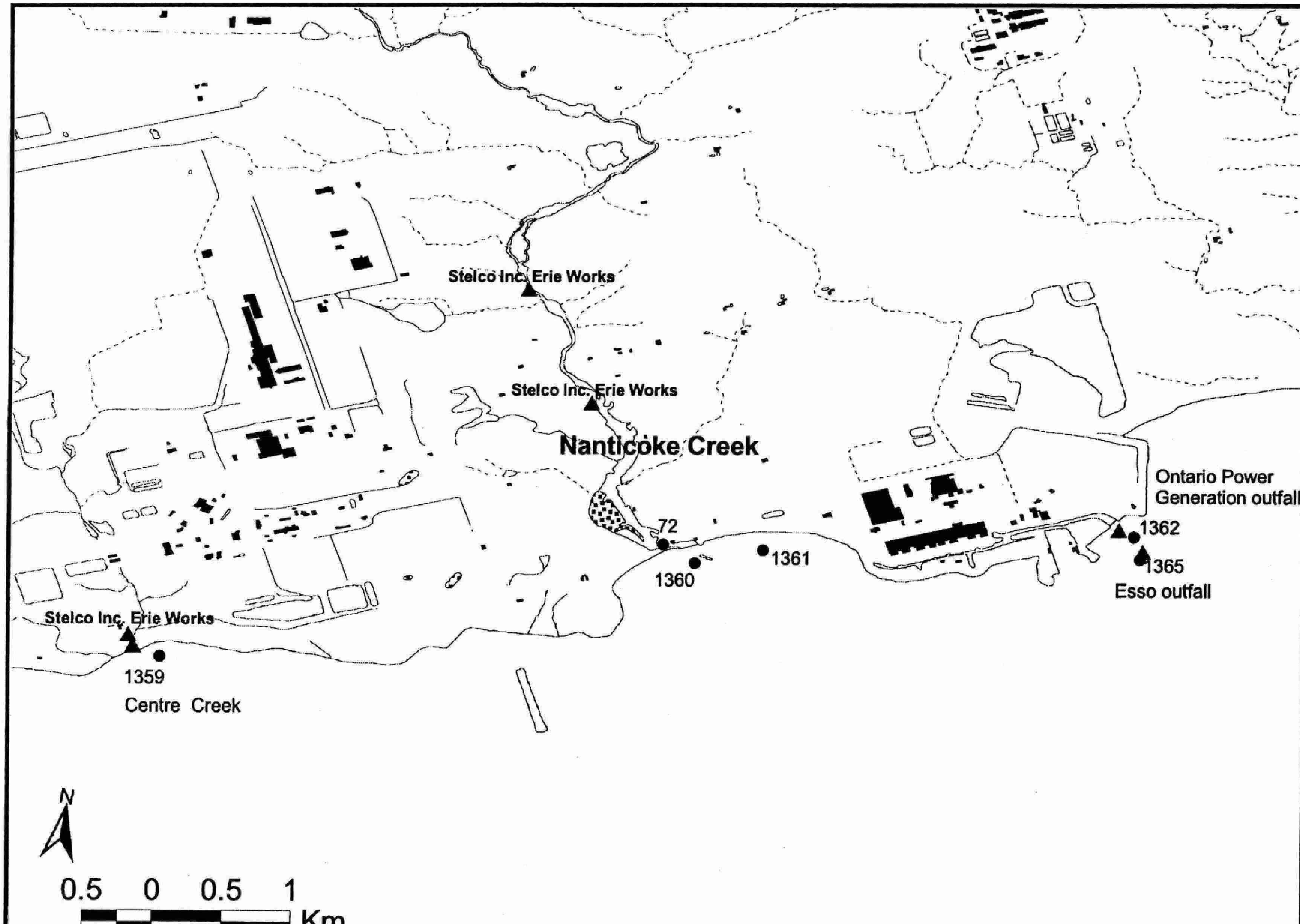


Figure 5: Nanticoke Sampling Stations

Most of the farming in the area is crop farming although there are some large animal farming operations (animals are typically raised in barns but there are environmental issues related to manure storage and applications to farmland), and some dairy operations which allow the animals to roam from the barn during the day. The creek also flows through wetlands. The towns of Waterford (located about 30 km upstream of the creek mouth), and Townsend (located about 15 km upstream), are situated along the creek and primarily discharge storm water. The population of Waterford is about 3,500 while the town of Townsend has a population of less than 2,000. The Waterford sewage lagoons have a continuous discharge to the creek with an average flow of 2,000 m^3/day. The Townsend sewage lagoon discharges to the creek only in November and December.

Numerous storm sewers discharge to the creek about 3 km upstream of the creek mouth particularly in the area of the Lake Erie Industrial Park. As well, the Lake Erie Steel Company discharges stormwater from two settling ponds to Nanticoke creek. A small marina for recreational boating is located at the creek mouth. The mean daily discharge for Nanticoke Creek ranged from 0 to 25.9 m^3/sec (Gauging station ID 02GC022). On the sampling day in April the discharge was 3.86 m^3/sec which was similar to flow rates measured for at least two weeks prior to sampling. The mean daily discharge from Nanticoke Creek on the remaining sampling days were; (summer: 0.064 m^3/sec; fall: 0.061 m^3/sec).

All water and sediment data are provided in Tables 4 to 7 and Figures 6 to 9 following the description and interpretation of the data for Port Dover and Nanticoke

Water Quality

At both Port Dover and Nanticoke surface water temperature and dissolved oxygen concentrations were consistent between stations for each sampling survey with the exception of slightly higher water temperatures at the stations near the Ontario Power Generation outfall and Esso outfall in the Nanticoke area (Table 4).

The surface water temperature in Port Dover ranged from 12.1 to 13.8 °C in the spring, 23.2 to 23.9 °C in the summer and from 12.6 to 13.0 °C in the fall. Dissolved oxygen concentrations were unavailable in the spring. Concentrations were lower in the summer than the fall and ranged from 6.0 to 7.9 mg/L and 8.7 to 10.6 mg/L respectively.

At Nanticoke the water temperature in the spring ranged from 12.0 to 14.0 °C, in the summer from 22.7 to 25.5 °C and in the fall from 11.5 to 18.0 °C. Dissolved oxygen concentrations in the summer ranged from 6.0 to 7.8 mg/L. There was no data for the fall and only three values for the spring (9.3 to 11.3 mg/L) due to equipment failure.

Secchi depth readings were low exhibiting poor water clarity at the tributary stations in both Port Dover and Nanticoke and at the inner harbour stations for Port Dover while stations located near the Ontario Power Generation and Esso outfalls had the highest secchi depth readings (2- 4 m).

Bacteriological Analysis

There was some evidence of bacterial contamination in both study areas. However, in general bacterial counts were low throughout the survey.

At Port Dover the highest *Escherichia coli* (*E. Coli*) and fecal streptococci counts were present in samples collected in August at the Lynn River upstream station (station 15-69) (160/100 mL). In general, bacteria was higher in the Lynn River and Black Creek compared with the lake station and station near the WPCP, suggesting sources within both the Lynn River and Black Creek. With the exception of the two stations in the Lynn River, all counts were below the Ontario Ministry of Health Guideline for recreational water quality which is 100 *E. coli* per 100 ml sample (Table 4).

Bacterial contamination in the Nanticoke area was low. The highest counts were consistently present in samples collected from the mouth of Nanticoke Creek (*E. Coli*-292/100mL and fecal strep. - 228/100 mL in August). In general, the highest bacterial levels were present in August and the lowest levels were in October. With the exception of the samples at the mouth of Nanticoke Creek, all samples were below the guideline for recreational water quality. The data suggest sources of bacteria in Nanticoke Creek. There are several possible upstream sources (eg. storm sewers, sewage lagoons and agricultural runoff).

Suspended Solids

Suspended solid concentrations in the spring were high in samples from Black Creek (56.5 mg/L) and the Lynn River (range: 14.0 to 29 mg/L), in contrast with the Lake Erie station (1.0 mg/L) (Figure 6 & 7).

Suspended solids concentrations were similar in the summer and fall at all river and creek sites and they were lower than in the spring (summer/fall range: 5.0 to 13.0 mg/L). Water collected from the Lake Erie station and the station near the WPCP had low concentrations of suspended solids in the spring, while in the summer and fall concentrations at the WPCP were greater than in the Lynn River and Black Creek. The high suspended solid concentrations at this station may be due to bank erosion into Lake Erie and possibly due to contributions from the WPCP. The limited number of samples does not allow for definitive source identification.

High concentrations of suspended solids were present in water collected from Nanticoke Creek during all three surveys (Table 4 & Figure 8) with the highest concentrations in the spring (64 mg/L). Nanticoke Creek may have impacted nearshore concentrations of suspended solids to the east and west of the creek mouth in the spring and summer although high concentrations may also be due to bank erosion.

In the summer survey, high suspended solids were detected in the water sample collected from Centre Creek (36.5 mg/L) while concentrations were only at 1.5 and 1.0 mg/L in the spring and

fall. The cause of the high loadings at the time of sampling was unknown but may be related to variability in discharges from the Lake Erie Steel Company since the flow from this creek is mostly treated effluents and storm water from the facility. As well, the high concentrations could be related to high loadings from Nanticoke Creek or due to shoreline erosion since the other nearshore stations also had high suspended solid concentrations. The stations at the Ontario Power Generation outfall and Esso outfall consistently had low suspended solids concentrations (< 3 mg/L).

Total Phosphorus

High total phosphorus and nitrogen concentrations at stations within the Lynn River, Black Creek and Nanticoke Creek suggest that the tributaries were nutrient enriched and were a source of nutrients to Lake Erie. Intensive agricultural land use upstream of the creeks and the Lynn River combined with the presence of the Simcoe WPCP (Lynn River) and Waterford and Townsend sewage lagoons (Nanticoke Creek) may have contributed phosphorus to these tributaries (Figures 7 & 8).

Overall, the highest total phosphorus concentrations were present in water samples collected from the two stations in the Lynn River and from Black Creek in the spring and summer survey (range: 76 to 144 *u*g/L) suggesting eutrophic conditions. TP concentrations were lower in the fall than the spring at those stations but were still higher than concentrations at other sampling sites (range: 40 to 68 *u*g/L). Concentrations were greater than the Provincial Water Quality Objective (PWQO) at all three stations for each sampling event.

Total phosphorus concentrations decreased downstream. The lake station had the lowest phosphorus concentrations in all three surveys (<PWQO 20 *u*g/L).

Water samples collected near the Port Dover WPCP had higher TP concentrations than the lake station. The PWQO in August and October was exceeded at that site suggesting local nearshore influences (i.e. the WPCP). TP was weakly correlated with suspended solids concentrations ($r=0.54$ $p<0.05$).

Nanticoke Creek had the highest total phosphorus concentrations throughout the three surveys with concentrations greater than the PWQO (range: 38 *u*g/L to 160 *u*g/L)(Figure 8). Phosphorus concentrations in water at stations on either side of the creek mouth (station 1361 and station 1360) may be elevated due to high concentrations of phosphorus in the creek and high concentrations of suspended solids in the samples. Total phosphorus concentrations were greater than the PWQO at these two stations in April and August (range: 26 to 62 *u*g/L), but concentrations at these sites were lower than at the creek mouth. Water collected from the station near Centre Creek also had high phosphorus concentrations in August (72 *u*g/L) coinciding with high suspended solid concentrations. TP concentrations were highly correlated with suspended solids ($r=0.92$ $p<0.05$).

Nitrogen

Consistent with the phosphorus data, the highest concentrations of total inorganic nitrogen (TIN) were present in the Lynn River and Black Creek throughout the three surveys (range: 2.31 to 2.65 mg/L). Concentrations were similar for all sampling events and in combination with phosphorus data represented eutrophic conditions. Concentrations of TIN at the mouth of the harbour were similar to upstream concentrations in the Lynn River in April (2.52 mg/L) but were lower than the upstream concentrations in August and October possibly due to a dilution effect from Lake Erie (0.83 and 1.50 m/L respectively).

TIN concentrations at the lake station were the same as concentrations at the WPCP station and were considerably lower than at the Lynn River and harbour mouth (range: 0.10 to 0.48 mg/L). The lowest TIN concentrations at these two sites were present in August while the highest concentrations were present in the spring and fall. Unlike the upstream stations these two stations exhibited patterns of TIN representative of the nitrogen cycle. The upstream stations had consistently high concentrations of TIN with no seasonal variability.

Concentrations of total organic nitrogen (TON) were also highest in water samples collected from the Lynn River and Black Creek (range: 0.42 mg/L to 0.89 mg/L).

At Nanticoke, TIN concentrations were greatest in the spring samples similar to other survey areas. The highest concentration was in the sample from the mouth of Nanticoke Creek (3.23 mg/L) which was at least three times greater than the concentrations at other sampling sites. Concentrations decreased at the two stations on either side of the creek (0.81 and 0.88 mg/L) but were still high and suggest that there was an influence from the creek on the nearshore water quality of Lake Erie in this area. The lowest concentrations were at the Ontario Power Generation and Esso outfalls (0.38 and 0.39 mg/L respectively).

TIN concentrations were similar at all stations in August (range: 0.23 to 0.29 mg/L) and in October (range: 0.34 to 0.36 mg/L) with the exception of the water collected from the mouth of the creek in October (0.14 mg/L) which had the lowest concentrations, and the site off Centre Creek (Stelco outfall) (0.62 mg/L) with the highest concentrations.

The highest TON concentrations throughout the survey were present in water collected from the mouth of Nanticoke Creek (range: 0.49 to 0.95 mg/L). Concentrations at the remaining stations ranged from 0.21 mg/L to 0.40 mg/L.

Chloride and Conductivity

In general, the tributaries had high chloride concentrations and, as such, were a source of chloride to Lake Erie (Figures 7 & 8).

At Port Dover, the highest chloride concentrations were in the Lynn River and Black Creek and a

downstream gradient was evident in all three surveys. The lowest concentrations were present in April (range: 20 to 29 mg/L). Concentrations in August and October were similar and ranged from 32 to 55 mg/L. Water collected from the lake station and the station near the WPCP ranged from 15-17 mg/L. Chloride concentrations were highly correlated ($r=0.92$ $p<0.05$) with conductivity.

As expected, the Lynn River and Black Creek had the highest conductivity values. Conductivity in the summer and fall were similar and higher than values for spring in the river and creek. Conductivity at the lake station and WPCP was similar for all three surveys (range: 270 to 290 *u*S/cm).

With only one exception (Centre Creek in October - 37 mg/L), the highest chloride concentrations were present at the mouth of Nanticoke Creek (range: 23 to 33 mg/L). Chloride concentrations were similar at all remaining sites for all sampling events (range: 15 to 18 mg/L).

Trace Metals

Concentrations of all trace metals in water samples from both survey areas were below the Provincial Water Quality Objectives (PWQO) with the exception of aluminum, chromium and iron.

At Port Dover Al and Fe concentrations were highly correlated with suspended solids ($r= 0.93$ and $r=0.83$ respectively). This may mean that the high concentrations of Al and Fe were associated with suspended particulate matter and may explain some of the high concentrations in the water samples. However, Cr concentrations were not correlated with suspended solids, therefore, concentrations above the PWQO should be noted. Although since Cr was only present at trace concentrations data should be interpreted with caution.

In April concentrations were greater than the PWQO for Al, Fe and Cr VI at all stations in the Lynn River and Black Creek. Suspended solids concentrations were high at some sites and ranged from 14 to 57 mg/L likely influencing the water concentrations of Fe and Al. In the summer and fall surveys samples collected from some stations had water with concentrations greater than the PWQO for either Al, Fe and/or Cr (Appendix D).

At Nanticoke, Al and Fe concentrations in water were also correlated with suspended solids ($r=0.92$ and 0.96 respectively), while Cr concentrations were only weakly correlated with suspended solids ($r=0.54$). In April Al, Cr and Fe concentrations were greater than the PWQO in the two samples collected from the mouth of Nanticoke Creek. Suspended solids were high at this station (62 and 64 mg/L) and likely influenced the high metal concentrations. Al concentrations were greater than the guideline at the two stations on either side of the creek and Cr was greater than the PWQO at one of the stations. Al concentrations were greater than the PWQO at the station near Centre Creek (although concentrations were lower at this site than near Nanticoke Creek). While concentrations of Cr were greater than the PWQO (Cr VI) at the

Ontario Power Generation outfall and the Esso outfall it is noteworthy that suspended solids were low at these two stations (1.0 mg/L).

In August Al concentrations were greater than the PWQO at the same sites as in April while Fe was greater than the PWQO at the mouth of Nanticoke Creek, on the west side of the creek mouth and at the station near Centre Creek. In October only Al was greater than the PWQO at the station near Centre Creek. This was the only station with elevated suspended solids concentrations (8.5 mg/L).

Sediment Quality

Sediment Physical Qualities

Sediment samples collected from both study areas had variable physical characteristics which can influence contaminant concentrations. In particular sediment collected from the Lynn River upstream of the harbour mouth and from Black Creek were high in silt and clay while the remaining sites in the area were high in sand content. TOC concentrations were similar at all stations with the exception of the Port Dover lake station and the upper Lynn River station which were low in TOC and high in sand. These physical characteristics will greatly reduce the likelihood of high contaminant concentrations.

Similarly, stations at Nanticoke tended to be high in sand content, in particular the site near Centre Creek which was also low in TOC. In general, sediment collected from Nanticoke were lower in TOC than samples collected from Port Dover. The sediment collected from the Ontario Power Generation station had the highest silt and clay content relative to the other sites in the Nanticoke study area.

Metals and Nutrients

Concentrations of some metals, nutrients and total PAHs in sediment were greater than the Provincial Sediment Quality Guidelines (PSQG) Lowest Effect Level (LEL) at some stations in the Port Dover area. The highest concentrations of metals in sediment were from samples collected from Port Dover at the ship storage area (16-2), in the Lynn River upstream of the harbour mouth (station 15-70), and at the Black Creek site. Lead and zinc concentrations at the ship storage area were noteworthy given the high sand content of the sediment (Table 5 & Figure 9). Copper, manganese, phosphorus and TOC concentrations in sediment were greater than the LEL at almost all stations in Port Dover. Sediment contaminant concentrations at the lake station were all less than the LEL. Low concentrations of metals and nutrients at this station were likely due to the low TOC concentrations in the sediment and the high sand content. Although sediment contaminant concentrations were greater than the LEL at some stations, concentrations were less than and/or similar to the Lake Erie and mean Great Lakes background values with the exception of As, Mn and Zn which were up to two times higher than the background values at some

stations (Mudroch et al. 1988; Persaud et al. 1992). This data suggests that sediment metal contamination at Port Dover was minimal.

When the sediment data was normalized for particle size the ship storage area showed enrichment for lead, copper and zinc relative to the other sites that were sampled. One possibility for metal enrichment at this site may be the historical activities at the ship storage area which included sand blasting, ship painting with lead based paints and the use of fungicides that contained copper. However, present concentrations in sediment were not high enough to be of significant biological concern. Sediment from the downstream sites show some enrichment for these same metals relative to the stations upstream in the Lynn River and Black Creek.

Metal concentrations in sediment from the Nanticoke area were low in general. Concentrations at all stations were below the LEL with the exception of the site located near the Ontario Power Generation outfall. Sediment concentrations of copper, iron, manganese, nickel, TKN, phosphorus and TOC were greater than the LEL at that site. Phosphorus and TOC concentrations were greater than the LEL at three of the four sites sampled.

Although concentrations of all trace metals were below the LEL at the site off Centre Creek (so there are no implications for impacts on biota), particle size corrected data suggest sediment enrichment with cobalt, chromium, iron, zinc and phosphorus. The sediment collected from the site near the Ontario Power Generation outfall suggests enrichment of copper relative to the other sites in the study area. The higher concentrations of the other parameters at this site compared with other sampling sites was likely due to the high silt/clay content of the sediment sample.

Organochlorine Pesticides and Chlorinated Benzenes

Chlorinated benzenes were not detected in sediment samples collected from Port Dover or Nanticoke.

Polychlorinated biphenyl (PCBs) were not detected in sediment from either study area with the exception of one of three replicate samples at station 15-70 (upstream from the mouth of the Harbour) at Port Dover where concentrations of PCBs were 40 ng/g.

Trace concentrations of γ-BHC and γ-chlordane were detected at two stations (15-70 and 15-69) in the Lynn River at Port Dover. Sediment collected from all stations in Port Dover had p,p'-DDE with the exception of the Port Dover lake station (Table 5). The highest concentrations were in samples collected from station 15-70 upstream from the mouth of the harbour and from the station at the ship storage area (16-2). Concentrations of p,p'-DDE at these two sites were above the Provincial Sediment Quality Guidelines (PSQG) lowest effect level (LEL) and ranged from 12 to 15 ng/g at station 15-70 and from 7 to 16 ng/g at station 16-2. Trace concentrations of p,p'-DDT were also detected in one of three replicate samples at each of these two stations. These data suggest historical local use of these compounds.

Trace concentrations of p,p'-DDE (2-3 ng/g) were detected at two stations in the Nanticoke area; near the Esso outfall and at the mouth of Nanticoke Creek.

Polycyclic Aromatic Hydrocarbons (PAHs).

Similar to results for the other parameters, the highest concentrations of PAHs were detected in sediment from the tributaries (Table 6 & 7). PAHs were present in sediment collected from all stations in Port Dover. However, sediment from the lake station only had trace concentrations of fluoranthene, pyrene and phenanthrene in one sample. As with the metal data, the low sediment concentrations and relatively low detection of individual PAH compounds was likely due to the low TOC concentrations and high sand content of the samples. The highest concentrations of PAHs were present in sediment collected from station 15-70 (upstream from the mouth of the harbour, total PAH range:1,840 to 6,700 ng/g) and from station 16-2 at the ship storage area (total PAH range: 5000 to 5580 ng/g). These were the only two stations where total PAH concentrations were above the LEL (4 *u*g/g).

Concentrations of PAHs in sediment were low in the Nanticoke area. The highest concentrations were present at the site at the mouth of Nanticoke Creek (total PAH: 600 to 1680 ng/g). PAHs detected at other sites were all at trace concentrations. Trace concentrations of pyrene and fluoranthene were present at most sites. PAHs were not detected at the site located near Centre Creek.

Table 4: Concentration of nutrients, conventional parameters and bacteria in water collected from Port Dover and Nanticoke, 1998

Station Description	Station number			Date YYYYMMDD	Water Depth (m)	Sample Depth (m)	Secchi Depth (m)	Water Temp °C	DO (field) mg/L as O	Conductivity (field) uS/cm 25 C	pH	pH (Field)	*E. coli* count/100mL	RMK	Fecal Streptococci count/100mL	RMK	*Pseudomonas aeruginosa* count/100mL	RMK	Chloride mg/L	RMK	Ammonia/ ammonium mg/L	RMK	Nitrite mg/L	RMK	Nitrite/Nitrate mg/L	RMK	Total Inorganic Nitrogen	TKN mg/L	RMK	Total Organic Nitrogen	Total Phosphorus mg/L	RMK	Suspended Solids mg/L	RMK
Spring																																		
Port Dover-WPCP outfall	16	1	1364	19980422	2.0	1.0	2.0	13.0	-	296		-	4	<	4	<	0		16.8		0.002	<=W	0.005		0.480		0.482	0.30		0.30	0.010		1.5	<T
Port Dover-lake stn	16	1	1358	19980422	5.4	1.5	4.5	12.1	-	290		-	4	<	4	<	0		16.8		0.002	<=W	0.003	<T	0.435		0.437	0.26		0.26	0.008	<T	1.0	<T
Split	16	1	1358	19980422	5.4	1.5	4.5	12.1	-	290		-	4	<	4	<	0		16.6		0.002	<=W	0.004	<T	0.440		0.442	0.30		0.30	0.012		1.0	<T
Port Dover-Harbour	16	17	62	19980422	3.9	1.5	0.5	13.1	-	525		-	30	<=>	40	<=>	4	<	26.4		0.080		0.037		2.440		2.520	0.02	<=W	-0.06	0.004	<T	29.5	
Port Dover-Lynn River	16	15	70	19980422	3.5	1.5	0.4	13.8	-	551		-	120		90	<=>	4	<	28.0		0.078		0.033		2.480		2.558	0.80		0.72	0.104		23.0	
Port Dover-Lynn River	16	15	69	19980422	2.3	1.0	0.5	13.5	-	585		-	40		24		2	<	29.0		0.050		0.033		2.510		2.560	0.60		0.55	0.076		14.0	
Port Dover-Black Creek	16	15	68	19980422	3.1	1.5	0.3	12.8	-	502		-	30	<=>	50	<=>	4	<	20.4		0.074		0.040		2.410		2.484	0.96		0.89	0.144		56.5	
Summer																																		
Port Dover-WPCP outfall	16	1	1364	19980825	1.9	0.7	0.6	23.8	7.4	295			4	<	4	<	2	<	15.8		0.028		0.004	<T	0.140		0.168	0.38		0.35	0.046		28.5	
Port Dover-lake stn	16	1	1358	19980825	5.1	1.5	1.0	23.9	7.9	283			12		4		2	<	15.2		0.006	<T	0.003	<T	0.095		0.101	0.34		0.33	0.018		6.5	
Port Dover-Harbour	16	17	62	19980825	3.5	1.5	0.4	23.8	7.1	385			40		44		2	<	29.0		0.072		0.017		0.760		0.832	0.52		0.45	0.076		36.0	
Port Dover-Lynn River	16	15	70	19980825	2.7	1.3	1.2	23.7	6.0	612			40		56		2	<	48.6		0.232		0.046		2.080		2.312	0.68		0.45	0.080		9.0	
Port Dover-Lynn River	16	15	69	19980825	2.0	1.0	0.8	23.2	7.8	652			160		44		2	<	48.8		0.236		0.053		2.390		2.626	0.76		0.52	0.106		11.0	
Split	16	15	69	19980825	2.0	1.0	0.8	23.2	7.8	651			156		76		2	<	48.6		0.240		0.053		2.410		2.650	0.74		0.50	0.100		11.5	
Port Dover-Black Creek	16	15	68	19980825	2.9	1.4	0.9	23.6	6.4	650	8.1		44		32		2		49.4		0.244		0.054		2.360		2.604	0.70		0.46	0.086		13.0	
Fall																																		
Port Dover-WPCP outfall	16	1	1364	19981028	0.9	0.4	0.9	13.0	10.1	270		8.07	4	<	4	<	2	<	16.0		0.002	<=W	0.006		0.355		0.357	0.28		0.28	0.022		17.0	
Split	16	1	1364	19981028	0.9	0.4	0.9	13.0	10.1	270		8.07	4	<	4	<	2	<	16.2		0.002	<=W	0.004	<T	0.355		0.357	0.26		0.26	0.024		18.0	
Port Dover-lake stn	16	1	1358	19981028	5.0	1.5	1.9	12.6	10.5	254		8.14	8		4	<	2	<	15.0		0.002	<=W	0.004	<T	0.255		0.257	0.24		0.24	0.012		4.0	
Port Dover-Harbour	16	17	62	19981028	3.3	1.5	1.2	12.9	9.2	460		7.98	12		4		2	<	31.6		0.018		0.017		1.480		1.498	0.38		0.36	0.028		7.5	
Port Dover-Lynn River	16	15	70	19981028	2.6	1.1	1.5	12.6	9.1	598		8.04	40		44		2	<	45.4		0.038		0.028		2.330		2.368	0.46		0.42	0.040		5.0	
Port Dover-Lynn River	16	15	69	19981028	1.5	0.7	0.8	12.8	10.6	652		8.23	80		296		2	<	47.4		0.002	<=W	0.037		2.830		2.832	0.56		0.56	0.068		10.0	
Port Dover-Black Creek	16	15	68	19981028	2.4	1.2	1.0	12.6	8.7	678		7.96	84		24		2	<	55.0		0.044		0.028		2.370		2.414	0.50		0.46	0.048		7.0	
Spring																																		
Nanticoke-Ontario Power Gen	16	1	1362	19980422	5.7	1.5	4.0	13.7	-	274		8.17	4		4	<	0		16.4		0.002	<=W	0.002	<T	0.390		0.392	0.22		0.22	0.014		1.0	<T
Nanticoke-Esso outfall	16	1	1365	19980422	7.1	1.5	3.5	14.0	-	274		8.20	4	<	4	<	0		16.4		0.002	<=W	0.001	<=W	0.380		0.382	0.24		0.24	0.010		1.0	<T
Nanticoke Creek	16	1	1361	19980422	2.2	1.0	1.0	12.2	-	319	8.04	8.17	8		12		0		18.4		0.012		0.014		0.865		0.877	0.40		0.39	0.036		9.5	
Nanticoke Creek (mouth)	16	15	72	19980422	2.5	1.2	0.2	12.1	9.3	521		8.04	50	<=>	120		4	<	23.4		0.046		0.051		3.180		3.226	1.00		0.95	0.160		64.0	
Split	16	15	72	19980422	2.5	1.2	0.2	12.0	9.3	521		8.04	70	<=>	60	<=>	4	<	23.6		0.046		0.053		3.220		3.266	1.00		0.95	0.160		62.0	
Nanticoke	16	1	1360	19980422	0.5	1.3	1.1	13.2	11.3	307		8.23	4	<	4		0		18.2		0.016		0.013		0.790		0.806	0.42		0.40	0.026		5.0	
Nanticoke-Stelco outfall	16	1	1359	19980422	1.4	0.5	1.4	13.3	-	305		-	4	<	4	<	0		18.4		0.002	<=W	0.007		0.505		0.507	0.38		0.38	0.018		1.5	<T
Summer																																		
Nanticoke-Ontario Power Gen	16	1	1362	19980826	5.2	1.5	2.5	24.7	7.2	285			20		4	<	0		15.2		0.034		0.004	<T	0.260		0.294	0.28		0.25	0.012		3.0	
Split	16	1	1362	19980826	5.2	1.5	2.5	24.6	7.2	287			4		4	<	0		15.2		0.032		0.004	<T	0.255		0.287	0.30		0.27	0.018		3.0	
Nanticoke-Esso outfall	16	1	1365	19980826	6.6	1.5	2.0	25.5	7.3	285			4		4		0		15.2		0.016		0.003	<T	0.210		0.226	0.28		0.26	0.014		3.0	
Nanticoke	16	1	1361	19980826	1.5	0.6	0.6	22.7	7.4	302	8.12		52		24		2		17.6		0.046		0.006		0.215		0.261	0.36		0.31	0.030		11.5	
Nanticoke Creek (mouth)	16	15	72	19980826	2.2	2.2	0.1	23.4	6.0	369			292		228		10		26.2		0.096		0.012		0.165		0.261	0.76		0.66	0.100		39.5	
Nanticoke	16	1	1360	19980826	1.0	0.5	0.2	23.0	7.8	294			12		4		0		16.4		0.036		0.008		0.235		0.271	0.42		0.38	0.062		60.5	
Nanticoke-Stelco outfall	16	1	1359	19980826	1.1	0.5	0.8	23.8	7.3	309			4	<	8		0		19.8		0.026		0.006		0.265		0.291	0.40		0.37	0.072		38.5	
Fall																																		
Nanticoke-Ontario Power Gen	16	1	1362	19981029	4.9	1.5	3.5	16.0	-	270		-	4		8		0		15.4		0.012		0.005		0.340		0.352	0.22		0.21	0.008	<T	1.0	<T
Nanticoke-Esso outfall	16	1	1365	19981029	6.3	1.5	4.0	15.2	-	254	8.16	-	16		12		0		15.2		0.010		0.005		0.335		0.345	0.22		0.21	0.008	<T	1.5	<T
Nanticoke	16	1	1361	19981029	1.2	0.5	1.2	11.9	-	238		-	4	<	4	<	0		16.2		0.008	<T	0.005		0.340		0.348	0.22		0.21	0.008	<T	1.0	<T
Nanticoke Creek (mouth)	16	15	72	19981029	2.0	1.0	1.0	11.5	-	365		-	8		4		2	<	32.6		0.054		0.005		0.085		0.139	0.54		0.49	0.038		8.5	
Nanticoke	16	1	1360	19981029	1.2	0.6	1.2	11.8	-	245		-	4	<	4	<	0		17.2		0.016		0.005		0.345		0.361	0.24		0.22	0.010		2.0	<T
Split	16	1	1360	19981029	1.2	0.6	1.2	11.8	-	246		-	4	<	4	<	0		17.2		0.016		0.005		0.340		0.356	0.24		0.22	0.008	<T	2.0	<T
Nanticoke-Stelco outfall	16	1	1359	19981029	1.2	0.6	1.2	12.0	-	327		-	4	<	4	<	0		36.8		0.016		0.007		0.600		0.616	0.26		0.24	0.016		1.0	<T
Port Dover- (F-blank)				19980422															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.06	<T	0.06	0.004	<T	0.5	<W
Port Dover- (F-blank)				19980825															0.2	<=W	0.004	<T	0.001	<=W	0.005	<=W	0.009	0.02	<=W	0.02	0.002	<=W	0.5	<W
Port Dover- (F-blank)				19981028															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.02	<=W	0.02	0.002	<=W	0.5	<W
Nanticoke- (F-blank)				19980826															0.2	<=W	0.002	<=W	0.001	<=W	0.015	<T	0.017	0.04	<T	0.04	0.004	<T	0.5	<T
Nanticoke- (F-blank)				19981029															0.2	<=W	0.002	<=W	0.001	<=W	0.010	<T	0.012	0.02	<=W	0.02	0.002	<=W	0.5	<W
Nanticoke Creek-(T-blank)				19981026															0.2	<=W	0.006	<T	0.001	<=W	0.015	<T	0.021	0.02	<=W	0.01	0.002	<=W	0.5	<W

<W no measurable response
<T measurable trace amount, interpret with caution
<=> approximate value
F-blank field blank
T-blank travel blank

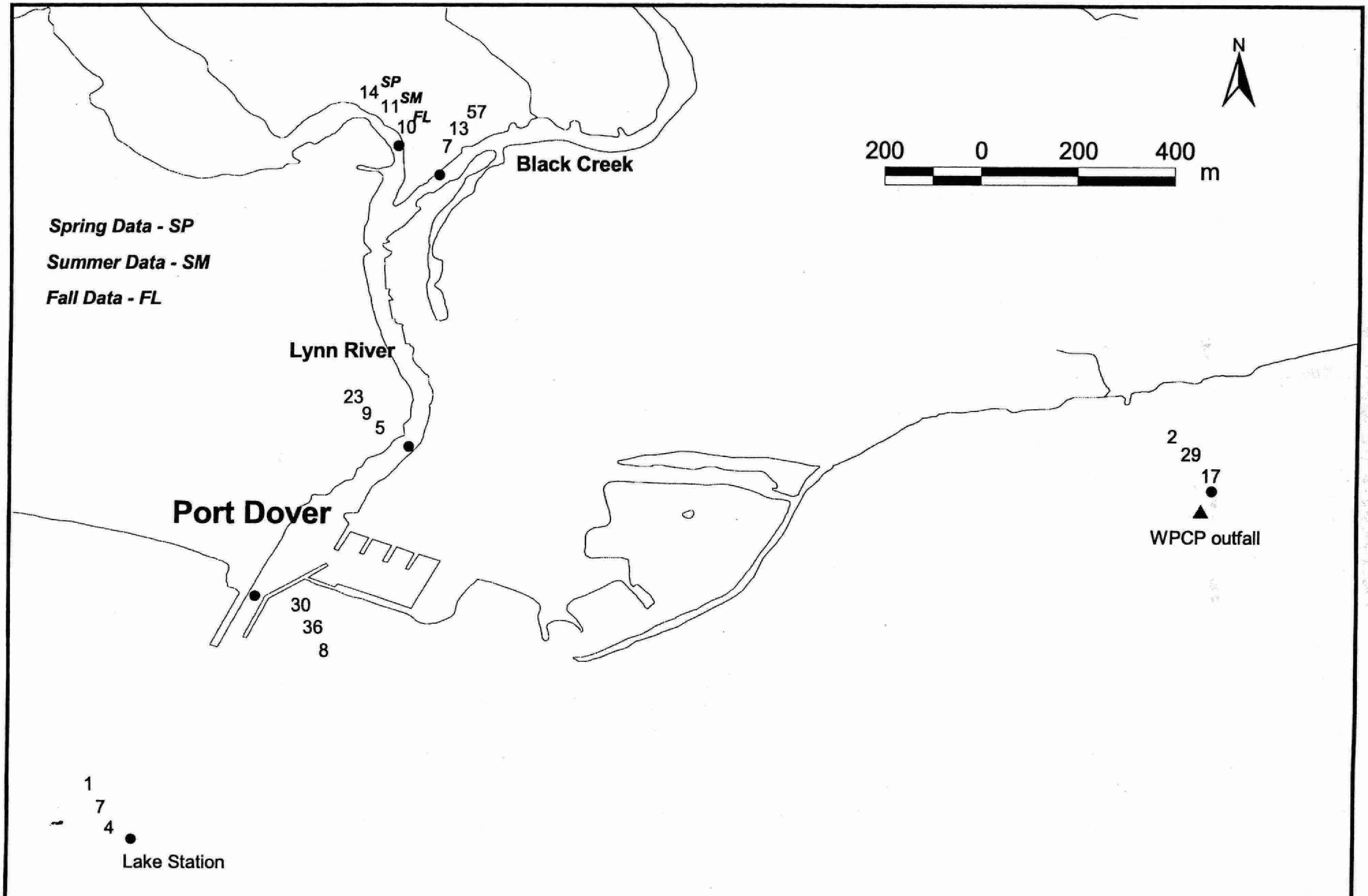
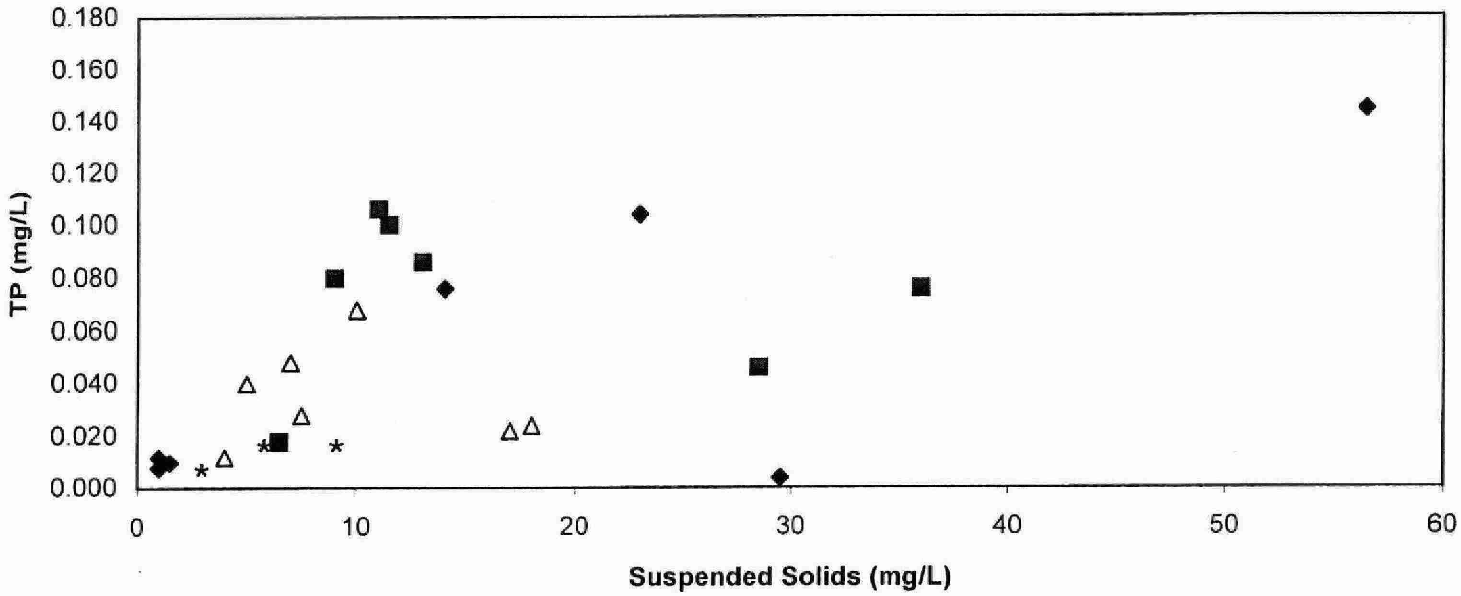
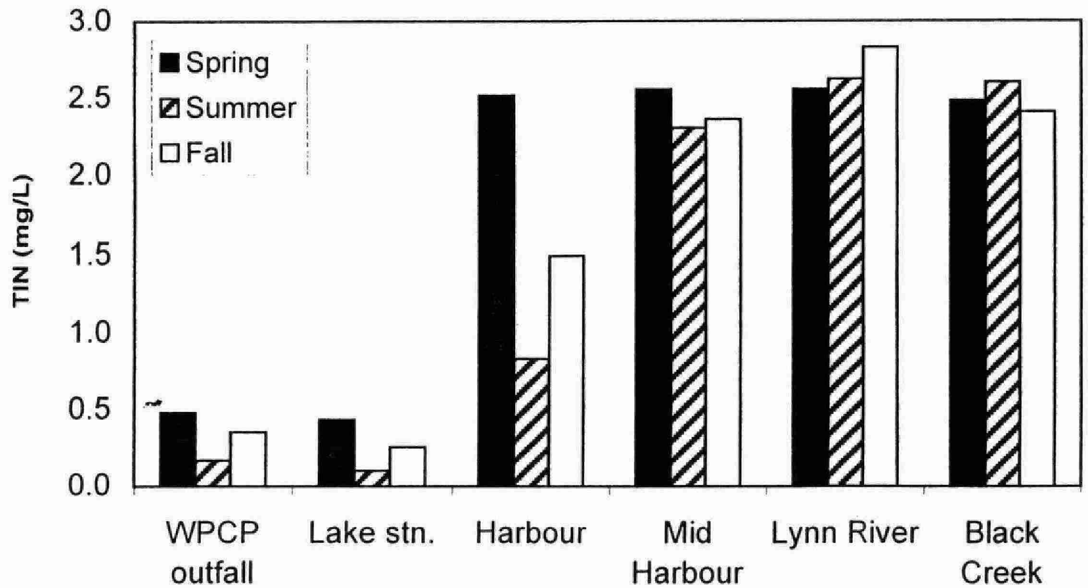


Figure 6: Spring, Summer & Fall Suspended Solids Concentration (mg/L), Port Dover, 1998

Figure 7: Water quality parameters in surface grab samples - Port Dover, Lynn River & Black Creek, 1998





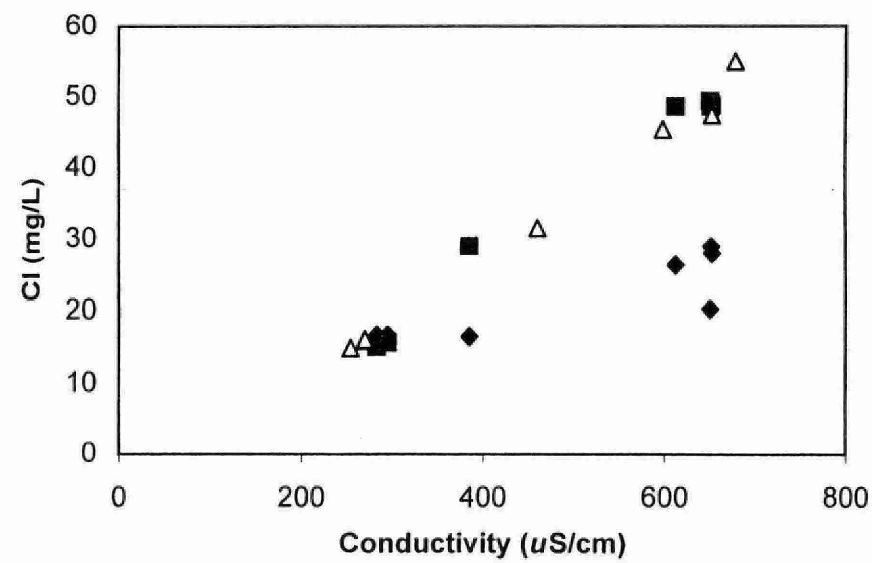
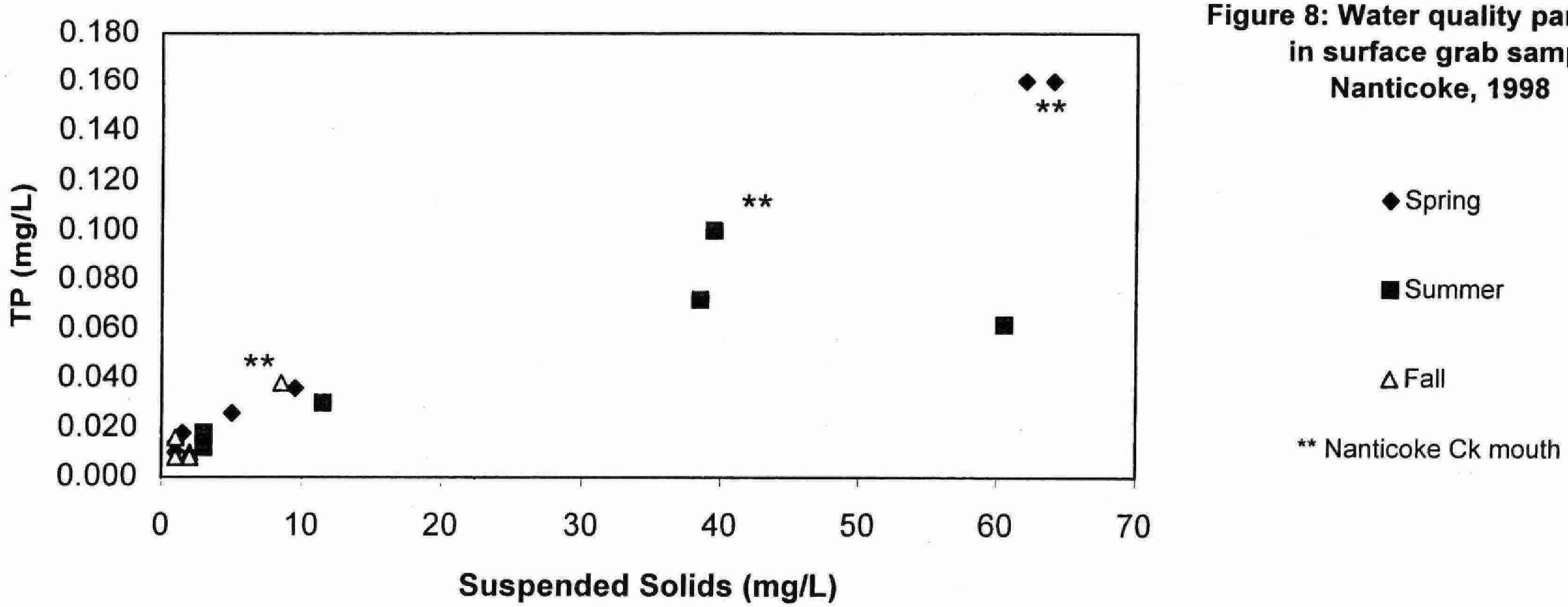
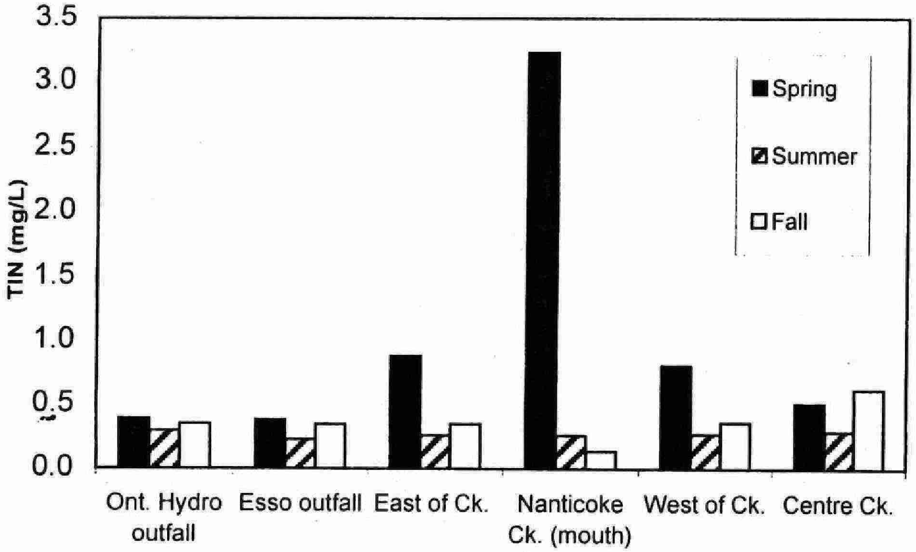


Figure 8: Water quality parameters in surface grab samples - Nanticoke, 1998





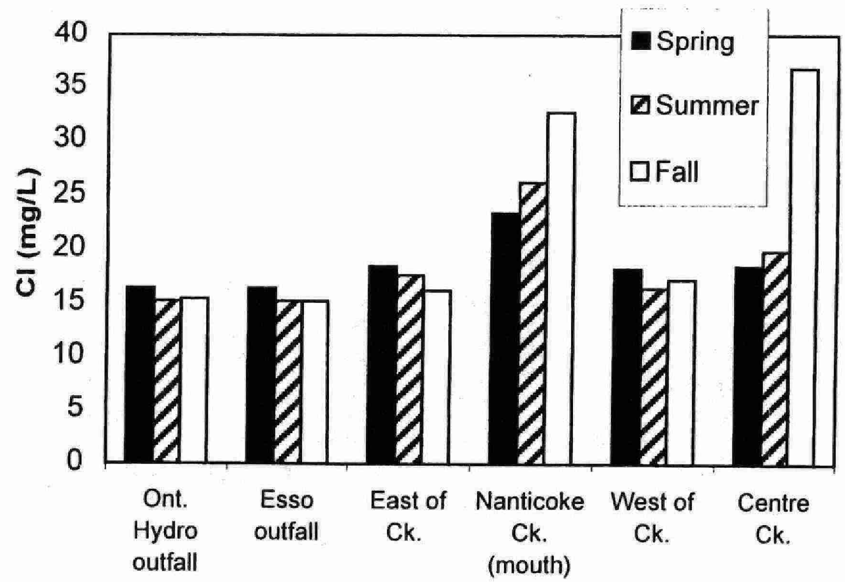


Table 5: Concentrations of nutrients, conventional parameters, metals and organics in sediment collected from Port Dover and Nanticoke, 1998

Station Description	Station Number		Date YYYYMMDD	Sample Depth (m)	Aluminum ug/g	Arsenic ug/g	Cadmium ug/g	RMK	Chromium ug/g	Copper ug/g	RMK	Iron ug/g	Mercury ug/g	RMK	Manganese ug/g	Nickel ug/g	Lead ug/g	RMK	Zinc ug/g	RMK	TKN mg/g	RMK	Total Phosphorus mg/g	Loss on Ignition (mg/g)	RMK	TOC (mg/g)	RMK	Clay %	RMK	Silt %	RMK	Sand %	RMK
Port Dover-Harbour	17	62	19980825	3.5	3300	1.0	0.2	<=W	8	20		9100	0.01	<=W	260	3.9	31		21	<T	0.1	<=W	0.4	5		47		1		3	<T	94	
	17	62	19980825	3.5	6900	2.2	0.2	<=W	12	12		12000	0.01	<=W	420	7.8	27		43		0.1	<=W	0.6	18		8		8		19		72	
	17	62	19980825	3.5	5400	1.7	0.2	<=W	9	11		9600	0.02	<T	360	6.3	17		32		0.1	<=W	0.6	15		9		5		13		81	
Port Dover-Lynn River	15	70	19980825	3.2	17000	4.6	0.4	<T	25	30		24000	0.08		710	18.0	29		110		1.0		1.3	47		12		30		68		2	<T
	15	70	19980825	3.2	20000	4.8	0.8	<T	30	35		27000	0.06		790	21.0	34		160		1.2		1.3	54		22		30		69		1	<=W
split	15	70	19980825	3.2	17000	4.8	0.2	<=W	28	37		24000	0.05		710	18.0	30		140		1.1		1.2	50		28		28		66		6	
split	15	70	19980825	3.2	18000	4.4	0.6	<T	27	34		24000	0.02	<T	730	19.0	31		140		1.0		1.1	48		20		25		60		15	
Port Dover-Lynn River	15	69	19980825	2.1	7800	3.2	0.2	<=W	13	12		14000	0.02	<T	530	8.8	12		53		0.1	<=W	0.7	18		11		13		25		62	
	15	69	19980825	2.1	6800	2.0	0.2	<=W	12	10		13000	0.02	<T	440	8.3	12		43		0.1	<=W	0.5	14		6		10		14		76	
	15	69	19980825	2.1	7500	2.9	0.2	<=W	14	12		14000	0.03	<T	550	8.8	31		62		0.2	<T	0.7	21		11		14		30		56	
Port dover-Black Creek	15	68	19980825	2.8	22000	4.8	0.4	<T	31	37		29000	0.03	<T	780	23.0	31		120		1.6		1.3	59		21		34		61		5	
	15	68	19980825	2.8	23000	4.7	0.5	<T	32	37		28000	0.04	<T	780	23.0	24		120		0.8		1.0	56		22		32		63		5	
	15	68	19980825	2.8	23000	5.1	0.4	<T	32	36		28000	0.04	<T	770	23.0	20		110		1.5		1.3	56		22		31		63		6	
Port Dover-lake stn	1	1358	19980826	5.2	3500	1.5	0.2	<=W	8	5		9400	0.03	<T	250	5.0	2	<=W	19	<T	0.1	<=W	0.4	7		4	<T	3		8		89	
	1	1358	19980826	5.2	3500	1.6	0.2	<=W	8	4	<T	9100	0.03	<T	250	4.9	2	<=W	17	<T	0.1	<=W	0.4	6		1	<=W	4		10		85	
Lynn River-ship storage	16	2	19980825	3.7	9200	4.5	0.3	<T	20	30		18000	0.04	<T	650	11.0	60		130		1.1		1.4	42		27		11.8		30		68	
	16	2	19980825	3.7	8600	3.3	0.6	<T	21	32		16000	0.05	<T	600	12.0	63		140		1.0		1.2	44		28		10.6		30		69	
Nanticoke-Ont Hydro outfall	1	1362	19980826	5.2	12000	4.5	0.2	<=W	21	30		28000	0.04	<T	540	23.0	8	<T	64		0.7		0.6	26		16		33		61		6	
Nanticoke-Esso outfall	1	1365	19980826	6.6	6400	2.1	0.2	<=W	13	13		12000	0.03	<T	410	9.1	2	<=W	36		0.1	<=W	0.6	16		10		12		46		42	
	1	1365	19980826	6.6	7000	1.9	0.2	<=W	12	13		12000	0.03	<T	420	9.5	2	<=W	39		0.4	<T	0.7	16		10		14		48		38	
	1	1365	19980826	6.6	7600	2.1	0.2	<=W	13	15		13000	0.04	<T	420	9.4	2	<=W	35		0.1	<=W	0.7	16		10		13		47		40	
Nanticoke Creek (mouth)	15	72	19980826	2.2	9600	2.0	0.2	<=W	15	11		13000	0.04	<T	360	11.0	7	<T	37		0.5		0.5	28		18		12		25		63	
	15	72	19980826	2.2	6800	1.7	0.2	<=W	11	8		10000	0.04	<T	300	7.4	2	<=W	25		0.3	<T	0.4	20		7		6		11		82	
split	15	72	19980826	2.2	12000	2.6	0.2	<=W	18	15		16000	0.05		470	15.0	7	<T	47		1.0		0.8	37		23		14		27		59	
split	15	72	19980826	2.2	10000	2.1	0.2	<=W	16	13		13000	0.05		400	12.0	7	<T	45		0.9		0.5	39		20		15		29		56	
Nanticoke-Stelco outfall	1	1359	19980826	1.1	3400	1.2	0.2	<=W	20	2	<T	28000	0.03	<T	370	5.7	2	<=W	31		0.1	<=W	1.6	3		1	<=W	1	<T	3	<T	96	
(off Centre Creek)	1	1359	19980826	1.1	3600	1.4	0.2	<=W	25	2	<T	30000	0.02	<T	380	5.6	2	<=W	31		0.1	<=W	1.1	2	<T	4	<T	1		3	<T	96	
	1	1359	19980826	1.1	3600	1.4	0.2	<=W	23	2	<T	30000	0.02	<T	380	5.6	2	<=W	27		0.1	<=W	1.6	14		1	<=W	1		3	<T	96	
Lowest Effect Level (ug/g)						6	0.6		26	16		20000	0.2		460	16	31		120		0.55 mg/g		0.6 mg/g			10 mg/g							
Severe Effect Level (ug/g) **						33	10		110	110		40000	2		1100	75	250		820		4.8 mg/g		2.0 mg/g			100 mg/g							
Background - Great Lakes pre-colonial sediment horizon, Persaud et al. (1992)						4.2	1.1		31	25		31000	0.1		400	31	23		65														
Background - Lake Erie pre-colonial sediment horizon for Harbours (H) and/or depositional zones (D), Mudroch et al. (1988)						0.5-1.2 (H)	0.1 (H) 0.1-1.7(D)		30-250(H) 9-25(D)	10-110(H) 20-48(D)		1000-15000(H) 8900-48200(D)	0.05-7(H)			55-65(H) 10-76(D)	21-49(D)		40-500(H) 8-128(D)														

<W no measurable response

<T measurable trace amount, interpret with caution

<=> approximate value

* - 10% of screening level concentration

P40 PCB resembles mixture of aroclor 1254 and 1260

Station Description	Station Number		Date	g-BHC ng/g	RMK	Chlordane ng/g	RMK	Total PCB ng/g	RMK	p'p-DDE ng/g	RMK	p'p-DDT ng/g	RMK
Port Dover-Harbour	17	62	19980825							4	<T		
	17	62	19980825							2	<T		
Port Dover-Lynn River	15	70	19980825							12			
	15	70	19980825							14		10	<T
split	15	70	19980825	3	<T			40	P40	15			
split	15	70	19980825	2	<T	4	<T			13			
Port Dover-Lynn River	15	69	19980825							3	<T		
	15	69	19980825	2	<T					2	<T		
	15	69	19980825							2	<T		
Port dover-Black Creek	15	68	19980825							3	<T		
	15	68	19980825							13			
	15	68	19980825							6	<T		
Lynn ~~River~~-ship storage	16	2	19980825							7	<T		
	16	2	19980825							16		30	<T
Nanticoke-Esso outfall	1	1365	19980826							2	<T		
	1	1365	19980826							2	<T		
Nanticoke Creek (mouth)	15	72	19980826							2	<T		
split	15	72	19980826							3	<T		
split	15	72	19980826							2	<T		
Lowest Effect Level (ng/g)				3*		7		70		5		8	

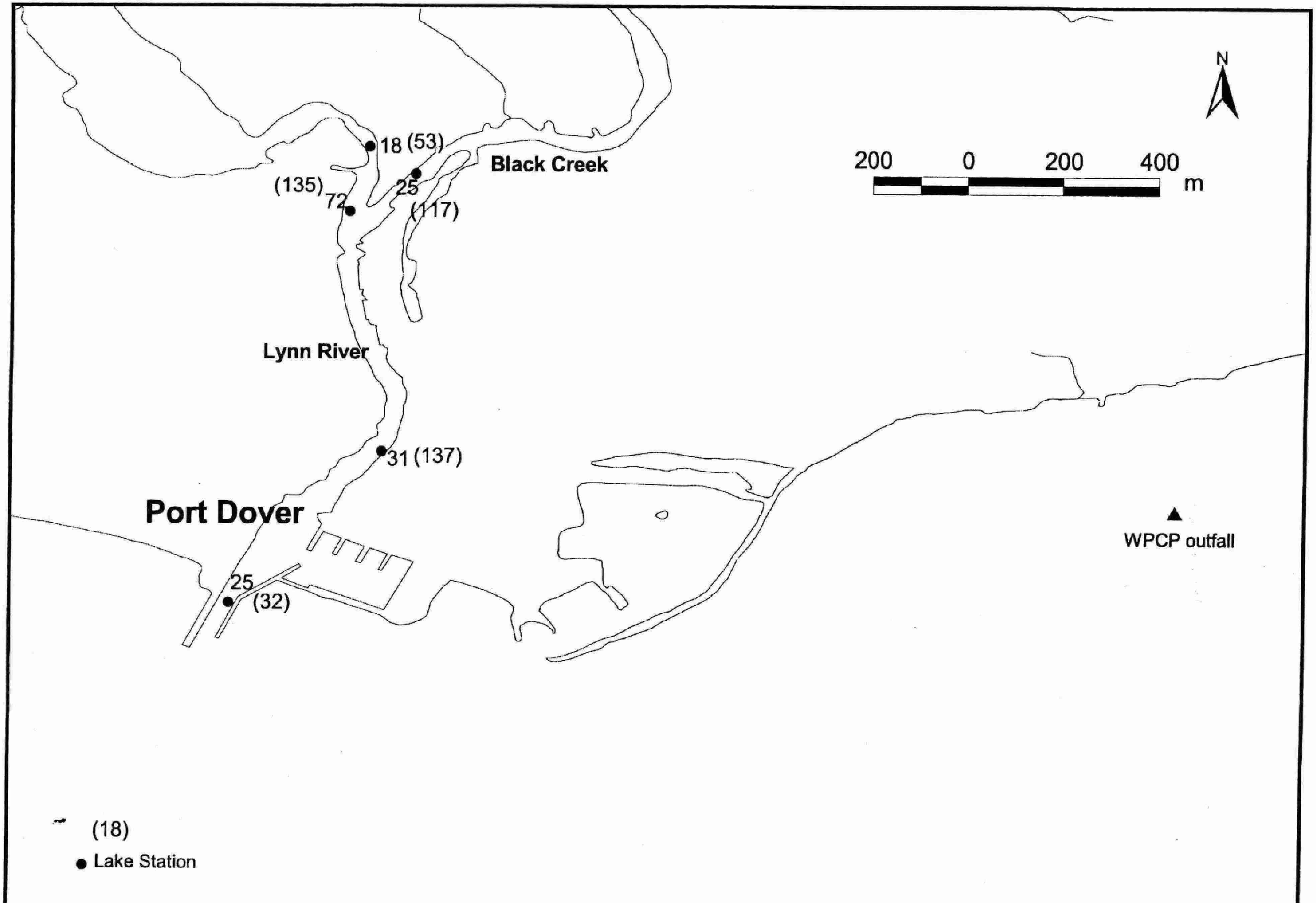


Figure 9: Sediment Lead (and Zinc) Concentrations (ug/g), Port Dover, 1998

Table 6: Concentrations of polycyclic aromatic hydrocarbons (ng/g) in sediment collected from Port Dover, 1998

Station Description	Station Number		Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b) fluoranthene	Benzo(k) fluoranthene	Chrysene	Dibenzo(ah) anthracene
Port Dover-Harbour	17	62	20 <=W	20 <=W	20 <=W	100	80 <T	80 <T	80 <T	80 <T	40 <=W
	17	62	20 <=W	20 <=W	80 <T	180	160 <T	140	140	180	40 <=W
	17	62	20 <=W	20 <=W	20 <=W	60 <T	80 <T	60 <T	60 <T	80 <T	40 <=W
Port Dover-Lynn River	15	70	20 <=W	20 <=W	40 <T	160	160 <T	200	160	200	40 <=W
	15	70	20 <=W	20 <=W	40 <T	140	160 <T	180	140	160	40 <=W
split	15	70	20 <=W	40 <T	80 <T	360	280	300	260	340	40 <=W
split	15	70	80 <T	60 <T	160	360	440	460	300	340	40 <=W
Port Dover-Lynn River	15	69	20 <=W	20 <=W	20 <=W	40 <T	40 <=W	40 <T	40 <T	60 <T	40 <=W
	15	69	20 <=W	20 <=W	20 <=W	40 <T	40 <=W	40 <T	40 <T	40 <T	40 <=W
	15	69	20 <=W	20 <=W	20 <=W	60 <T	80 <T	80 <T	80 <T	80 <T	40 <=W
Port dover-Black Creek	15	68	20 <=W	20 <=W	20 <=W	100	120 <T	140	120	140	40 <=W
	15	68	20 <=W	20 <=W	20 <=W	60 <T	80 <T	100	80 <T	100	40 <=W
	15	68	20 <=W	20 <=W	20 <=W	60 <T	80 <T	80 <T	60 <T	80 <T	40 <=W
Lynn River-Ship storage area	16	2	20 <=W	20 <=W	120	460	440	420	360	420	40 <=W
	16	2	20 <=W	40 <T	100	460	440	480	380	440	40 <=W
Port Dover-lake stn.	1	1358	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	1	1358	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Lowest Effect Level (ng/g)					220	320	370		240	340	60

Station Description	Station Number		Fluoranthene	Fluorene	Benzo(g,h,l) perylene	Indeno(1,2,3-cd) pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH
Port Dover-Harbour	17	62	200	20 <=W	80 <T	40 <=W	20 <=W	60 <T	180	940
	17	62	460	40 <T	120 <T	80 <T	20 <=W	380	320	2280
	17	62	160	20 <=W	40 <=W	40 <=W	20 <=W	100	140	740
Port Dover-Lynn River	15	70	400	20 <=W	160 <T	120 <T	20 <=W	200	340	2140
	15	70	340	20 <=W	120 <T	120 <T	20 <=W	160	280	1840
split	15	70	800	40 <T	200	160 <T	20 <=W	520	620	4000
split	15	70	1200	140	400	320	160	1300	1000	6720
Port Dover-Lynn River	15	69	100	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	80 <T	400
	15	69	80 <T	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	80 <T	320
	15	69	140	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	140	700
Port dover-Black Creek	15	68	340	20 <=W	80 <T	80 <T	20 <=W	160	240	1520
	15	68	200	20 <=W	80 <T	80 <T	20 <=W	80 <T	160	1020
	15	68	140	20 <=W	80 <T	40 <=W	20 <=W	80 <T	120	780
Lynn River-Ship storage area	16	2	940	20 <=W	280	240	20 <=W	540	780	5000
	16	2	1200	40 <T	280	280	20 <=W	580	860	5580
Port Dover-lake stn.	1	1358	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	1	1358	40 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	40 <T	120
Lowest Effect Level (ng/g)			750	190	170	200		560	490	4000
							Severe Effect Level (ng/g organic carbon)			10,000

<W no measurable response
<T measurable trace amount, interpret with caution

Table 7: Concentrations of polycyclic aromatic hydrocarbons (ng/g) in sediment collected from Nanticoke, 1998

Station Description	Station Number		Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b) fluoranthene	Benzo(k) fluoranthene	Chrysene	Dibenzo(ah) anthracene
Nanticoke-Ontario Hydro outfall	1	1362	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	60 <T	40 <=W
Nanticoke-Esso outfall	1	1365	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	1	1365	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	1	1365	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	40 <T	40 <=W
Nanticoke Creek (mouth)	15	72	20 <=W	20 <=W	40 <T	120	120 <T	120	100	120	40 <=W
Nanticoke Creek (mouth)	15	72	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
split	15	72	20 <=W	20 <=W	20 <=W	60 <T	40 <=W	40 <T	60 <T	60 <T	40 <=W
split	15	72	20 <=W	20 <=W	20 <=W	60 <T	40 <=W	60 <T	60 <T	60 <T	40 <=W
Nanticoke-Stelco outfall	1	1359	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
(off Centre Creek)	1	1359	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	1	1359	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Lowest Effect Level (ng/g)					220	320	370		240	340	60

Station Description	Station Number		Fluoranthene	Fluorene	Benzo(g,h,I) perylene	Indeno(1,2,3-cd) pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH
Nanticoke-Ontario Hydro outfall	1	1362	80 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	60 <T	240
Nanticoke-Esso outfall	1	1365	40 <T	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	40 <T	80
	1	1365	40 <T	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	40 <T	80
	1	1365	60 <T	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	40 <T	140
Nanticoke Creek (mouth)	15	72	400	20 <=W	80 <T	120 <T	20 <=W	180	280	1680
Nanticoke Creek (mouth)	15	72	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
split	15	72	140	40 <T	40 <=W	40 <=W	20 <=W	80 <T	120	600
split	15	72	200	60 <T	40 <=W	80 <T	20 <=W	140	160	880
Nanticoke-Stelco outfall	1	1359	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
(off Centre Creek)	1	1359	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	1	1359	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Lowest Effect Level (ng/g)			750	190	170	200		560	490	4000
							Severe Effect Level (ng/g organic carbon)			10,000

<W no measurable response
<T measurable trace amount, interpret with caution

PORT BURWELL

Port Burwell is located at the mouth of Big Otter Creek. The local WPCP is the main effluent source to the harbour which discharges through steel sheet piling along the wall of the harbour. The plant presently has secondary treatment. There is an oil tank storage area in the harbour and storm sewers discharge to the creek and harbour as well. A fish processing plant located about 1.5 km upstream of the harbour in Big Otter Creek is no loner in operation.

The population size of the municipality of Bayham /Port Burwell/ Vienna is about 5,800. The creek flows through the town of Port Burwell which is composed of small subdivision and trailer parks. Land use upstream is typically crop farming (corn, soybean, apple orchards, tobacco and peanuts), with few intensive livestock farms. The mean daily discharge for Big Otter Creek ranged from 1.7 to 71.4 m^3/sec in 1998 measured at the Calton gauging station located about 20 km upstream of the harbour (ID 02GC026). Annual discharge rates are provided in Appendix A. During the time of sampling flow was 6.1 m^3/sec on April 21 (flow was as high as 19 m^3/sec about a week prior to the survey), 2.6 m^3/sec on August 12, and 4.1 m^3/sec on November 11, 1998. During the August and November surveys flow was fairly consistent for several weeks prior to the surveys.

Water and sediment were collected from three stations in the survey area. At two additional stations only sediment was collected and at three stations only water was collected. Stations were located along Big Otter Creek, near the outfall from the WPCP (station 17-50) and at the mouth of the harbour. A lake station was located west of the harbour (01-1350) and one station was located east of the harbour (17-51)(Figure 10).

All water and sediment data are provided in Tables 8 to 10 and Figures 11 to13 following the description and interpretation of the data for Port Burwell.

Water Quality

Water temperature was consistent between stations within each survey. The spring water temperature ranged from 9.1 to 11.3 °C, summer temperatures ranged from 22.0 to 22.9 °C and fall water temperatures ranged from 5.3 to 8.5 °C.

Secchi depth readings were also consistent between stations within a survey exhibiting poor water clarity (less than 1 m) at all stations throughout the three surveys.

Dissolved oxygen concentrations in spring and fall were similar ranging from 9.7 to 12.0 mg/L, while summer concentrations were lower than the spring and fall (range: 7.9 to 9.3 mg/L).

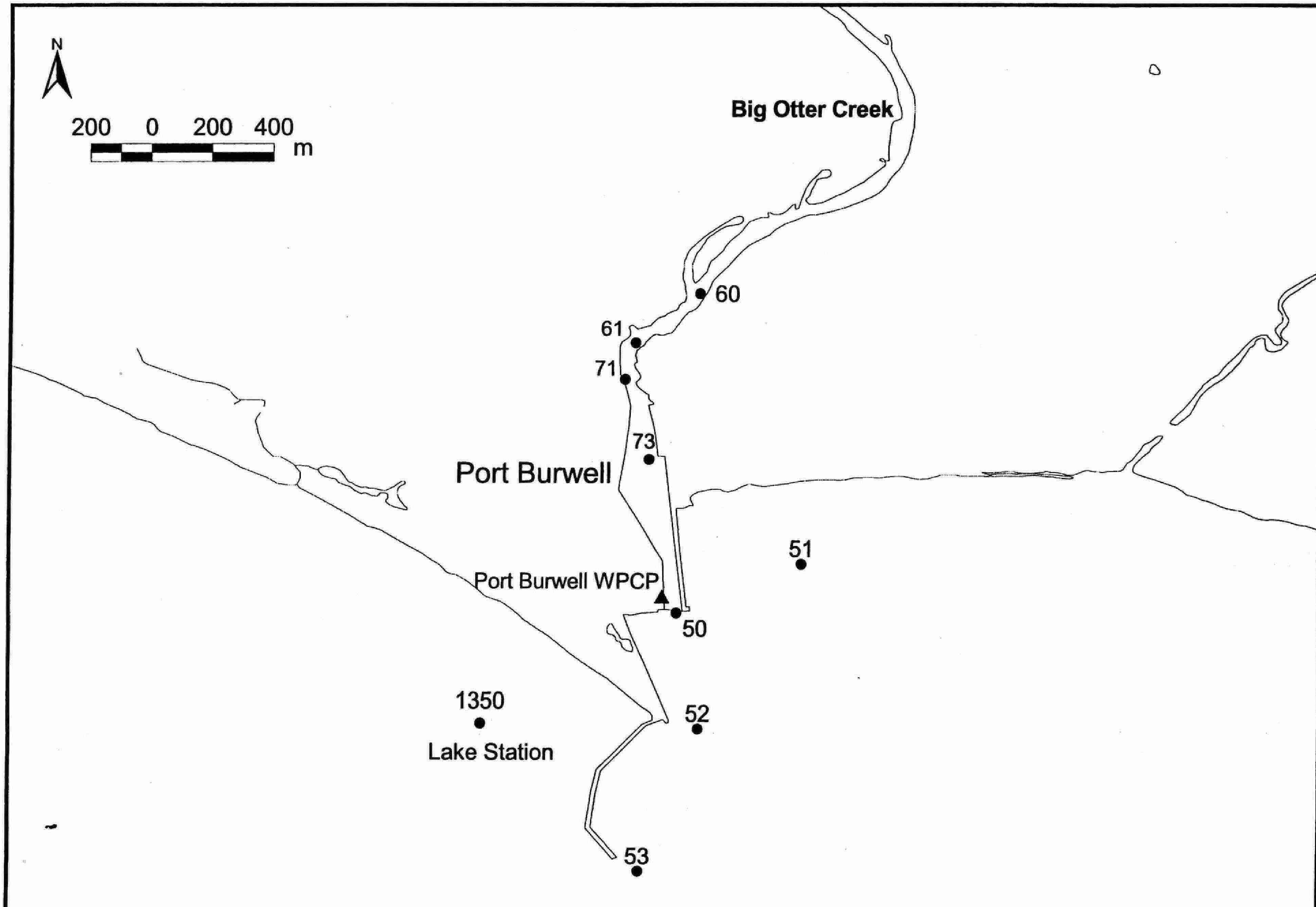


Figure 10: Port Burwell Sampling Stations

Bacteriological Analysis

Port Burwell and Big Otter Creek did not have high bacterial counts during the three surveys (Table 8). Although the highest counts were present in the summer, bacteria levels remained below the provincial recreational guideline (100 *E. coli* /100 mL) in all water samples. A downstream gradient was present with the highest bacteria levels in Big Otter Creek and at the mouth of the harbour (17-50).

Suspended Solids

Suspended solids concentrations in water collected from the outer harbour stations, the embayment and the lake station although high, were lower in spring (range: 7.0 to 9.5 mg/L) and summer (range: 4.5 to 15.5) relative to the fall concentrations (range: 93 to 134 mg/L). The high values in the spring and summer were likely due to suspended solid loadings from Big Otter Creek. However, the high suspended solids concentrations in the fall at these downstream stations were likely due to increased erosion of clay banks along Lake Erie during large storm events preceding the fall survey rather than loadings from the creek (Figure 11). Concentrations of suspended solids at the mouth of the harbour and at the upstream creek station were high in the spring (17 and 16.5 mg/L respectively) and summer (26.5 and 32 mg/L respectively) demonstrating a downstream gradient towards the lake station. However, in the fall, the downstream stations had higher suspended solid concentrations than the creek and harbour mouth stations which had relatively low suspended solids (4.0 and 4.5 mg/L). The fall secchi depth data and TP concentrations support this theory and suggest that the upstream station in Big Otter Creek was not influenced by Lake Erie water at the time of sampling.

Total Phosphorus

The outer harbour and lake stations had the highest TP concentrations in the fall (100 to 120 *ug*/L) likely due to the high suspended solid concentrations in the lake associated with the fall storm (Figure 12).

The highest concentrations in water in the spring and summer were present in samples collected from the Big Otter Creek site and at the harbour mouth (spring/summer range: 46 to78 *ug*/L). Concentrations at the remaining downstream stations decreased but were still greater than the PWQO at times (Table 8). Total phosphorus concentrations were correlated with suspended solids ($r=0.95$ $p<0.05$).

Nitrogen

The highest concentrations of TIN in all three surveys were present at the Big Otter Creek sampling site and the harbour mouth (range: 2.04 to 3.53) suggesting upstream sources (Figure 12). There was no seasonal variation in TIN concentrations at these two stations. Concentrations decreased in the embayment and outside the harbour breakwalls relative to the creek. TIN

concentrations were at least four times higher in Big Otter Creek and the harbour mouth compared with other downstream stations.

The highest concentrations of TON and TIN for the spring and summer were present in samples from Big Otter Creek and the harbour mouth (Figure 13). However, in the fall the two upstream stations had lower concentrations of TKN and TON than the outer harbour and lake stations although the TIN concentrations were still high. The ratio of TIN to TON suggests that during the spring and summer most of the nitrogen present in the water column was in the form of inorganic nitrogen. Likely sources of nitrogen to Big Otter Creek were surface runoff from agricultural practices upstream of the harbour since intensive cash crop and tobacco farming is typical for this area. In the fall only the upstream stations had high concentrations of inorganic nitrogen relative to organic nitrogen.

Chloride and Conductivity

For all three surveys chloride concentrations were similar at the lake station, outer harbour stations and embayment station (range 14 to 17 mg/L) while concentrations at the harbour mouth (17-50) and at the Big Otter Creek site were higher (range: 21 to 26 mg/L). Chloride concentrations in general were similar to the other survey areas with the exception of Port Maitland and Port Dover where higher concentrations were detected.

Conductivity followed the exact pattern as chloride. Concentrations in water from the harbour sites ranged from 273 to 326 *u*S/cm for all three surveys while concentrations at the inner harbour site and the Big Otter Creek site ranged from 491 to 552 *u*S/cm.

Trace Metals

Aluminum concentrations were greater than the PWQO in the spring, summer and fall surveys. High concentrations were likely due to the high suspended solids concentrations ($r=0.99$ $p<0.05$). The same is true for high concentrations of iron in the fall survey. Chromium concentrations were greater than the PWQO (Cr VI - 1 *u*g/L and Cr III- 8.9 *u*g/L) in some samples from the spring, summer and fall although concentrations were only weakly correlated with suspended solids ($r=0.43$ $p<0.05$). However, these values should be interpreted with caution since concentrations were close to the MDL and are described as trace (Figure 12).

Sediment Quality

Sediment Physical Qualities

Stations located outside the harbour and at the entrance to the harbour were high in percent sand (typically about 70% sand content). Silt and clay content increased upstream in Big Otter Creek. TOC concentrations were greater than the LEL at stations 15-71 and 15-61 (located upstream in Big Otter Creek), consistent with the higher clay and silt content.

Metals and Nutrients

Concentrations of all metals and nutrients were below the LEL for the entire harbour and Big Otter Creek with only a few exceptions: Mn at stations 15-71 and 15-61 (range from 530 to 580 *u*g/g and from 450 to 620 *u*g/g respectively) and Cu concentrations in some samples were equal to the LEL (16 *u*g/g) . TKN was greater than the LEL in one sample from station 15-73 and TP concentrations were greater than the LEL in at least one sample from most stations but concentrations were generally low (Table 9).

All sediment concentrations were less than the background values for Lake Erie and the Great Lakes with the exception of As concentrations in a few samples (Mudroch et al. 1988).

Organochlorine Pesticides and Chlorinated Benzenes

Organochlorine pesticides and chlorinated benzenes were not detected in any sediment samples with the exception of trace and/or low concentrations of DDE at stations in Big Otter Creek.

Polycyclic Aromatic Hydrocarbons (PAHs)

Only two PAH compounds (fluoranthene/fluorene) were detected (at trace concentrations) in sediment samples collected from station 16-61 while fluoranthene, phenanthrene and pyrene were detected at trace concentrations in samples from station 16-71.

Table 8: Concentration of nutrients, conventional parameters and bacteria in water collected from Port Burwell, 1998

Station Description	Station number			Date YYYYMMDD	Water Depth (m.)	Sample Depth (m.)	Secchi Depth (m)	Water Temp °C	DO (field) mg/L as O	Conductivity (field) uS/cm 25 C	pH	pH (Field)	*E. coli* count/100mL	RMK	Fecal Streptococci count/100mL	RMK	*Pseudomonas aeruginosa* count/100mL	RMK	Chloride mg/L	RMK	Ammonia/ ammonium mg/L	RMK	Nitrite mg/L	RMK	Nitrite/Nitrate mg/L	RMK	Total Inorganic Nitrogen	TKN mg/L	RMK	Total Organic Nitrogen	Total Phosphorus mg/L	RMK	Suspended Solids mg/L	RMK
Spring																																		
Port Burwell-lake stn.	16	1	1350	19980429	2.9	1.5	0.5	9.1	10.3	273		8.08	2	<	2	<	0				0.016		0.008		0.520		0.536	0.24		0.22	0.024		9.5	
Port Burwell-Harbour embayment	16	17	51	19980429	1.9	1.0	0.9	9.5	10.3	326		8.15	2	<	2	<	0				0.012		0.007		0.625		0.637	0.24		0.23	0.020		7.0	
Port Burwell-Harbour	16	17	53	19980429	4.3	1.5	0.8	9.2	9.9	285	8.15	8.12	2	<	2		0		16.2		0.022		0.009		0.660		0.682	0.26		0.24	0.024		7.5	
Split	16	17	53	19980429	4.3	1.5	0.8	9.2	9.9	284		8.13	2	<	2	<	0		16.0		0.010		0.006		0.645		0.655	0.26		0.25	0.028		7.5	
Port Burwell-Harbour	16	17	52	19980429	2.2	1.1	0.7	10.1	10.6	289		8.13	2	<	2	<	0		16.6		0.012		0.008		0.790		0.802	0.26		0.25	0.020		7.0	
Port Burwell-Harbour	16	17	50	19980429	1.3	0.5	0.5	11.3	9.7	528		8.14	6		8		0		21.2		0.006	<T	0.013		2.980		2.986	0.48		0.47	0.046		17.0	
Big Otter Creek (upstream of bridge)	16	15	60	19980429	1.2	0.5	0.5	10.8	9.7	552		8.17	16		18		0		24.0		0.002	<=W	0.022		3.530		3.532	0.52		0.52	0.054		16.5	
Summer																																		
Port Burwell-lake stn.	16	1	1350	19980812	2.4	0.7	1.1	22.4	7.9	266		8.39	12		10		0		14.2		0.016		0.005		0.220		0.236	0.24		0.22	0.010		4.5	
Port Burwell-Harbour embayment	16	17	51	19980812	1.7	0.8	0.5	22.9	8.3	277		8.41	20		74		2		14.6		0.006	<T	0.006		0.320		0.326	0.34		0.33	0.036		15.5	
Port Burwell-Harbour	16	17	53	19980812	4.0	4.0	0.9	22.8	8.2	277		8.42	2		12		0		14.8		0.004	<T	0.005		0.320		0.324	0.26		0.26	0.016		7.0	
Split	16	17	53	19980812	4.0	1.5	0.9	22.8	8.2	277		8.42	2		4		2		14.8		0.006	<T	0.006		0.310		0.316	0.26		0.25	0.012		6.5	
Port Burwell-Harbour	16	17	52	19980812	1.9	0.9	0.9	22.7	8.2	288		8.36	18		30		0		15.4		0.002	<=W	0.006		0.410		0.412	0.28		0.28	0.020		9.5	
Port Burwell-Harbour	16	17	50	19980812	1.1	0.4	0.3	22.0	8.4	494		8.24	76		60		2		22.8		0.002	<=W	0.018		2.040		2.042	0.56		0.56	0.066		26.5	
Big Otter Creek (upstream of bridge)	16	15	60	19980812	0.9	0.4	0.2	22.7	9.3	491		8.26	64		68		6		21.2		0.002	<=W	0.015		2.040		2.042	0.58		0.58	0.078		32.0	
Fall																																		
Port Burwell-lake stn.	16	1	1350	19981117	2.0	1.0	0.1	8.5	10.8	250		8.00	20	<=>	10	<	4	<	14.2		0.014		0.023		0.230		0.244	0.40		0.39	0.100		93.0	
Port Burwell-Harbour embayment	16	17	51	19981117	1.3	0.6	0.1	8.5	10.8	251		7.98	10	<=>	10	<	4	<	14.4		0.014		0.027		0.230		0.244	0.50		0.49	0.120		134.0	
Split	16	17	51	19981117	1.3	0.6	0.1	8.5	10.8	251		7.99	20	<=>	10	<=>	4	<	14.6		0.014		0.032		0.235		0.249	0.50		0.49	0.120		133.0	
Port Burwell-Harbour	16	17	53	19981117	3.6	1.5	0.1	8.5	10.8	258		8.00	10	<=>	20	<=>	4	<	14.8		0.012		0.025		0.315		0.327	0.40		0.39	0.100		103.0	
Port Burwell-Harbour	16	17	52	19981117	1.9	0.9	0.1	8.3	10.8	267		7.97	10	<	10	<	4	<	15.2		0.018		0.026		0.370		0.388	0.50		0.48	0.110		113.0	
Port Burwell-Harbour	16	17	50	19981117	0.9	0.4	0.9	5.3	11.5	536		8.03	80		80		2	<	25.6		0.018		0.011		2.700		2.718	0.38		0.36	0.018		4.5	
Big Otter Creek (upstream of bridge)	16	15	60	19981117	0.9	0.4	0.9	5.4	12.0	538		8.08	76		68		2	<	25.8		0.008	<T	0.009		2.810		2.818	0.32		0.31	0.018		4.0	
Big Otter Creek (F-blank)				19980429															0.2	<=W	0.010		0.001	<=W	0.005	<=W	0.015	0.02	<=W	0.01	0.002	<=W	0.5	<W
Big Otter Creek (T-blank)				19980429															0.2	<=W	0.010		0.001	<=W	0.005	<=W	0.015	0.02	<=W	0.01	0.002	<=W	0.5	<W
Big Otter Creek (F-blank)				19980812															0.2	<=W	0.002	<=W	0.001	<=W	0.010	<T	0.012	0.04	<T	0.04	0.004	<T	0.5	<W
Big Otter Creek (F-blank)				19981117															0.2	<=W	0.006	<T	0.001	<=W	0.010	<T	0.016	0.04	<T	0.03	0.002	<=W	0.5	<W
Big Otter Creek (T-blank)				19981112															0.2	<=W	0.004	<T	0.001	<=W	0.010	<T	0.014	0.50		0.50	0.130		0.5	<W

<W no measurable response
<T measurable trace amount, interpret with caution
<=> approximate value
F-blank field blank
T-blank travel blank

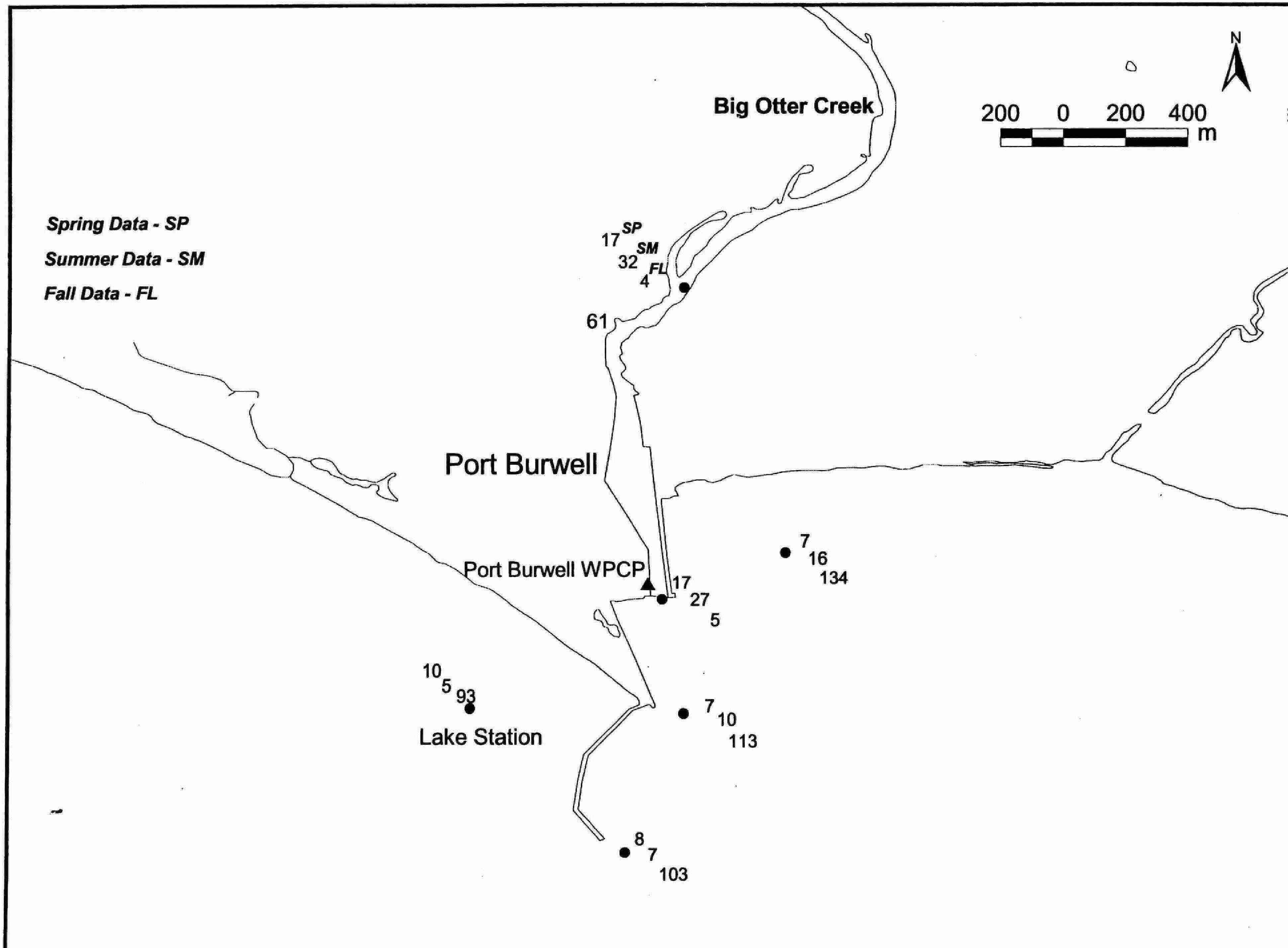
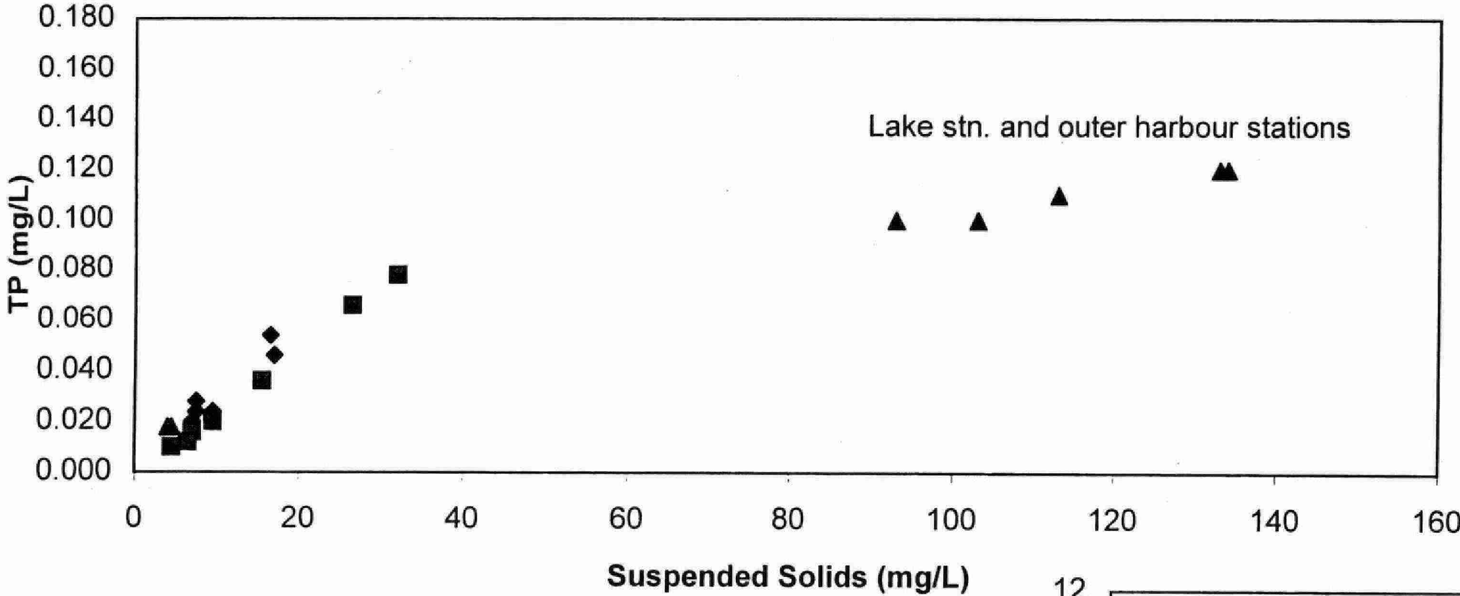
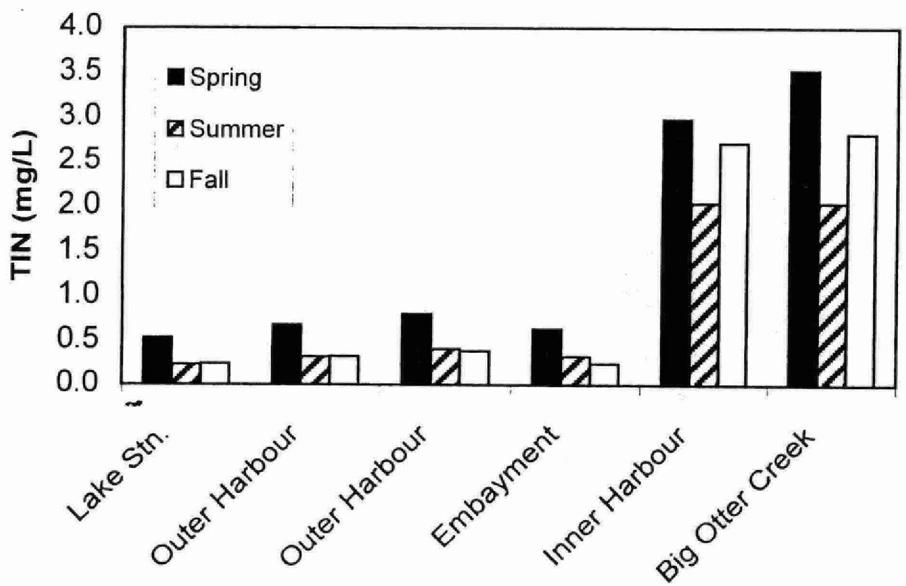


Figure 11: Spring, Summer & Fall Suspended Solids Concentration (mg/L), Port Burwell, 1998

Figure 12: Water quality parameters in Surface grab samples - Port Burwell and Big Otter Creek, 1998





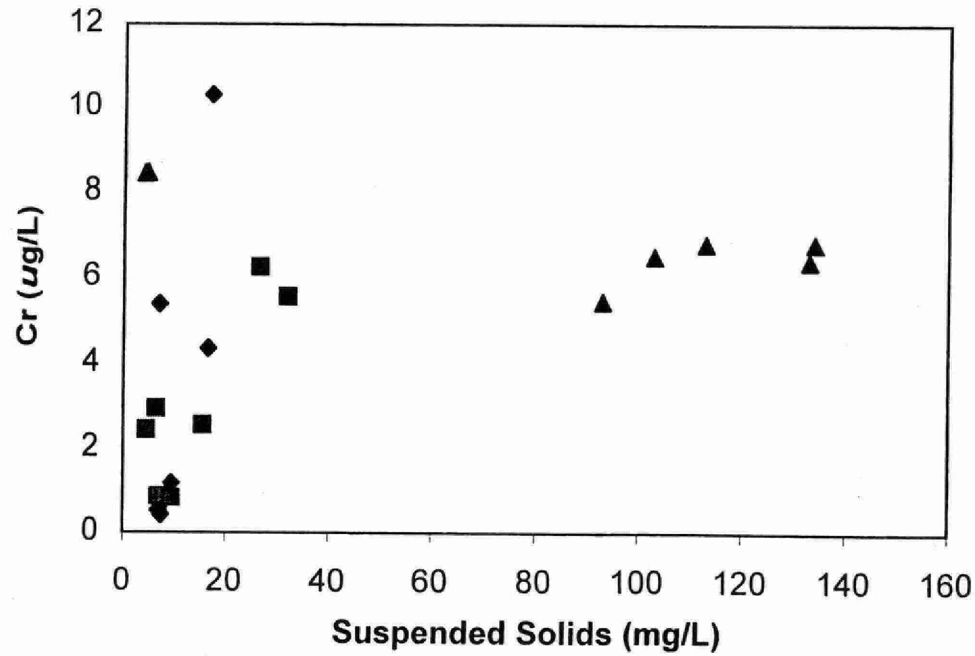


Figure 13:Ratio of TIN/TON in water samples collected from Port Burwell, 1998

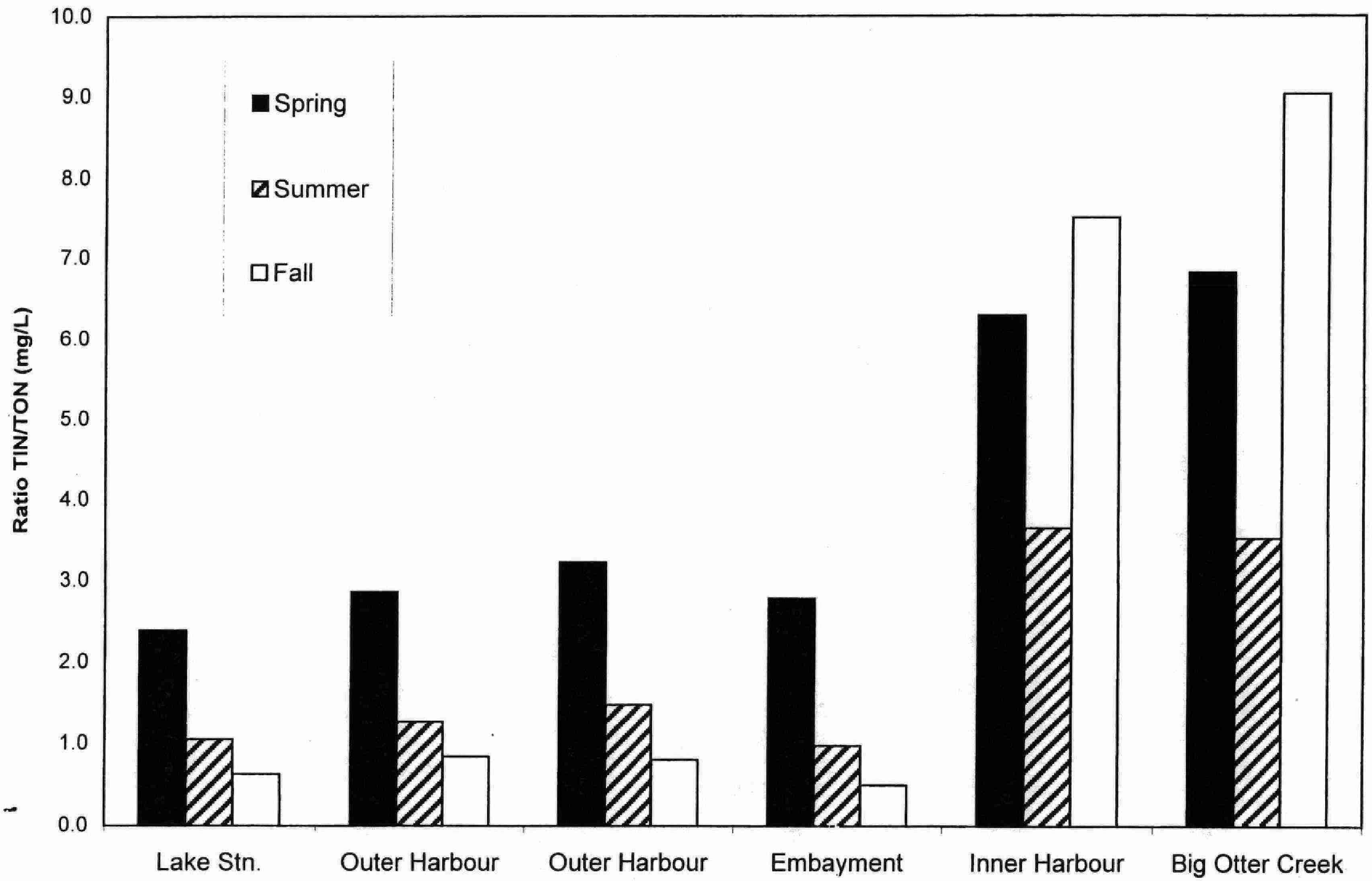


Table 9: Concentrations of nutrients, conventional parameters, metals and p'p-DDE in sediment collected from Port Burwell, 1998

Station Description	Station Number		Date YYYYMMDD	Sample Depth (m)	Aluminum ug/g	Arsenic ug/g	RMK	Cadmium ug/g	RMK	Chromium ug/g	Copper ug/g	RMK	Iron ug/g	Mercury ug/g	RMK	Manganese ug/g	Nickel ug/g	Lead ug/g	RMK	Zinc ug/g	RMK	TKN mg/g	RMK	Total Phosphorus mg/g	Loss on Ignition (mg/g)	RMK	TOC (mg/g)	RMK	Clay %	Silt %	Sand %
Port Burwell-lake stn.	1	1350	19980812	2.5	3300	1.2		0.3	<T	7	6		7600	0.01	<=W	290	3.5	2	<=W	23	<T	0.1	<=W	0.6	3		3	<T	4	24	73
	1	1350	19980812	2.5	3400	1.2		0.2	<=W	7	6		7300	0.02	<T	290	3.1	2	<=W	25		0.1	<=W	0.3	2	<T	1	<=W	4	26	71
	1	1350	19980812	2.5	3200	1.2		0.2	<=W	7	6		7500	0.01	<=W	280	3.3	4	<T	21	<T	0.1	<=W	0.6	3		6		3	20	76
Port Burwell-Harbour	17	52	19980812	1.9	3800	0.9	<T	0.2	<=W	8	5		7900	0.01	<=W	260	3.5	2	<=W	17	<T	0.1	<=W	0.7	8		10		5	23	72
	17	52	19980812	1.9	3700	0.9	<T	0.2	<=W	6	4	<T	7400	0.02	<T	250	3.2	2	<=W	17	<T	0.1	<=W	0.8	6		3	<T	4	22	74
	17	52	19980812	1.9	3700	1.0		0.2	<=W	7	5		7600	0.02	<T	270	3.5	3	<T	19	<T	0.1	<=W	0.6	9		10		6	29	65
Port Burwell-Harbour embayment	17	51	19980812	1.7	3500	1.0		0.2	<=W	7	5		7700	0.01	<=W	320	3.4	2	<=W	18	<T	0.1	<=W	0.7	2	<T	1	<=W	4	37	59
	17	51	19980812	1.7	4100	1.1		0.2	<=W	8	5		8400	0.02	<T	340	3.7	2	<=W	18	<T	0.1	<=W	0.3	3		2	<T	4	42	53
	17	51	19980812	1.7	4200	1.1		0.2	<=W	8	4	<T	8600	0.01	<=W	340	3.3	3	<T	18	<T	0.1	<=W	0.7	1	<T	7		4	40	55
Port Burwell-Big Otter Creek	15	73	19980812	0.9	4000	1.0		0.2	<=W	6	4	<T	6500	0.02	<T	220	3.2	2	<=W	19	<T	0.1	<=W	0.4	9		4	<T	4	12	84
	15	73	19980812	0.9	4800	1.1		0.2	<=W	8	5		7700	0.02	<T	260	3.8	2	<=W	23	<T	1.1		0.4	9		5		6	19	74
	15	73	19980812	0.8	4600	1.1		0.2	<=W	8	6		8100	0.02	<T	270	4.9	6	<T	25		0.1	<=W	0.5	13		11		7	23	70
Port Burwell-Big Otter Creek	15	71	19980812	3.8	10000	2.3		0.4	<T	15	16		14000	0.03	<T	530	9.9	9	<T	50		0.5		0.7	25		11		21	58	21
(south of bridge)	15	71	19980812	3.8	10000	2.5		0.3	<T	16	15		15000	0.02	<T	550	10.0	9	<T	49		0.5		0.6	27		13		20	56	24
	15	71	19980812	3.8	11000	2.6		0.3	<T	16	15		15000	0.03	<T	580	10.0	8	<T	49		0.1	<=W	0.2	27		13		22	59	18
Port Burwell-Big Otter Creek	15	61	19980812	1.8	7800	2.1		0.2	<=W	12	12		12000	0.03	<T	450	7.9	8	<T	38		0.1	<=W	0.2	27		11		16	47	38
	15	61	19980812	1.8	9200	2.3		0.4	<T	13	14		14000	0.03	<T	620	9.4	10		43		0.3	<T	0.6	28		12		17	48	36
split	15	61	19980812	1.6	12000	2.8		0.3	<T	16	16		16000	0.04	<T	620	12.0	10		51		0.3	<T	0.7	29		14		21	58	21
split	15	61	19980812	1.6	12000	2.9		0.4	<T	16	17		16000	0.03	<T	620	11.0	11		49		0.5		0.8	31		14		23	62	15
Lowest Effect Level (ug/g)						**6**		**0.6**		**26**	**16**		**20000**	**0.2**		**460**	**16**	**31**		**120**		**0.55 mg/g**		**0.6 mg/g**			**10 mg/g**				
Severe Effect Level (ug/g) **						**33**		**10**		**110**	**110**		**40000**	**2**		**1100**	**75**	**250**		**820**		**4.8 mg/g**		**2.0 mg/g**			**100 mg/g**				
Background - Great Lakes pre-colonial sediment horizon, Persaud et al. (1992)						**4.2**		**1.1**		**31**	**25**		**31000**	**0.1**		**400**	**31**	**23**		**65**											
Background - Lake Erie pre-colonial sediment horizon for Harbours (H) and/or depositional zones (D), Mudroch et al. (1988)						**0.5-1.2 (H)**		**0.1 (H) 0.1-1.7(D)**		**30-250(H) 9-25(D)**	**10-110(H) 20-48(D)**		**1000-15000(H) 8900-48200(D)**	**0.05-7(H)**			**55-65(H) 10-76(D)**	**21-49(D)**		**40-500(H) 8-128(D)**											

<W no measurable response

<T measurable trace amount, interpret with caution

<=> approximate value

Station Description	Station Number		p'p-DDE ng/g	RMK
Port Burwell-Big Otter Creek	15	73	2	<T
	15	73	3	<T
	15	73	4	<T
Port Burwell-Big Otter Creek	15	71	7	<T
(south of bridge)	15	71	9	<T
	15	71	9	<T
Port Burwell-Big Otter Creek	15	61	7	<T
	15	61	8	<T
split	15	61	10	
split	15	61	10	
Lowest Effect Level (ng/g)			**5**	

Table 10: Concentrations of polycyclic aromatic hydrocarbons (ng/g) in sediment collected from Port Burwell, 1998

Station Description	Station Number		Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b) fluoranthene	Benzo(k) fluoranthene	Chrysene	Dibenzo(ah) anthracene
Port Burwell-lake stn.	1	1350	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	1	1350	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	1	1350	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Port Burwell-Harbour	17	52	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	17	52	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	17	52	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Port Burwell-Harbour embaymen	17	51	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	17	51	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	17	51	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Port Burwell-Big Otter Creek	15	73	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	15	73	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	15	73	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Port Burwell-Big Otter Creek	15	71	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
(south of bridge)	15	71	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	15	71	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Port Burwell-Big Otter Creek	15	61	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	15	61	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
split	15	61	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
split	15	61	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Lowest Effect Level (ng/g)					220	320	370		240	340	60

Station Description	Station Number		Fluoranthene	Fluorene	Benzo(g,h,I) perylene	Indeno(1,2,3-cd) pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH
Port Burwell-lake stn.	1	1350	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	1	1350	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	1	1350	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Port Burwell-Harbour	17	52	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	17	52	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	17	52	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Port Burwell-Harbour embaymen	17	51	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	17	51	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	17	51	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Port Burwell-Big Otter Creek	15	73	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	15	73	20 <=W	40 <T	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40
	15	73	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Port Burwell-Big Otter Creek	15	71	20 <=W	40 <T	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40
(south of bridge)	15	71	20 <=W	40 <T	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40
	15	71	60 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	40 <T	140
Port Burwell-Big Otter Creek	15	61	40 <T	60 <T	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	100
	15	61	20 <=W	60 <T	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	60
split	15	61	20 <=W	40 <T	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40
split	15	61	20 <=W	40 <T	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40
Lowest Effect Level (ng/g)			750	190	170	200		560	490	4000
							Severe Effect Level (ng/g organic carbon)			10,000

<W no measurable response
<T measurable trace amount, interpret with caution

PORT BRUCE

Port Bruce is located at the mouth of Catfish Creek. There are two marinas, public beaches and a large trailer park located to the west of Catfish Creek. Catfish Creek flows through agricultural land used typically for crop farming similar to the land use upstream of Port Burwell (corn, soybean, tobacco and peanuts). A four cell sewage lagoon associated with the village of Almer WPCP discharges to the creek about 24 km upstream of Port Bruce and drains through the harbour.

Six stations were sampled for water and sediment (Figure 14). One station was located south of the mouth of the harbour to serve as a lake station (01-1354). One station was located in the embayment east of the harbour mouth (01-1352) in the vicinity of a beach. To measure gradients in water and sediment quality from Catfish Creek to the harbour entrance one station was located upstream in Catfish Creek and then a transect was set with three additional stations located progressively further downstream towards the harbour entrance. The annual flow for Catfish Creek ranged from 0.1 to 89.7 m^3/sec in 1998. During the time of sampling flow measurements were 2.0 m^3/sec on April 28, 0.2 m^3/sec on August 13, and 0.3 m^3/sec on October 22, 1998. Flow measurements were fairly consistent prior to the surveys although there were daily increases in flow measurements in April up to two weeks prior to sampling (Appendix A).

All water and sediment data are provided in Tables 11-12 and Figures 15 to 17 following the description and interpretation of the data for Port Bruce.

Water Quality

Water temperature was consistent at all stations for each season sampled. Temperature ranged from 8.9 to 12.6 °C in the spring (with the warmest temperatures in Catfish Creek), 23.3 to 24.8 °C in the summer and 10.5 to 13.1 °C in the fall (the coldest temperatures were present in Catfish Creek). Dissolved oxygen was also consistent between sites with the lowest concentrations in Catfish Creek in the summer (spring range: 11.4 to 13.6 mg/L; summer range: 6.4 to 8.4 mg/L; fall range: 9.3 to 10.3 mg/L).

Water clarity was poor due to high suspended solids loadings. Secchi disc depth readings were typically less than 0.5 m. The deepest secchi depth readings were consistently present at the lake station (range for three surveys: 0.5 to 1.9 m).

Bacteriological Analysis

Bacterial contamination was low at all stations. The highest bacterial counts (*E. Coli* and fecal strep.) were present in the summer in Catfish Creek but were consistently below the Ministry of Health guidelines (*E. Coli:* range 2 to 44 counts/100 mL; fecal streptococci: range 2 to 52 counts/100 mL)(Table 11).

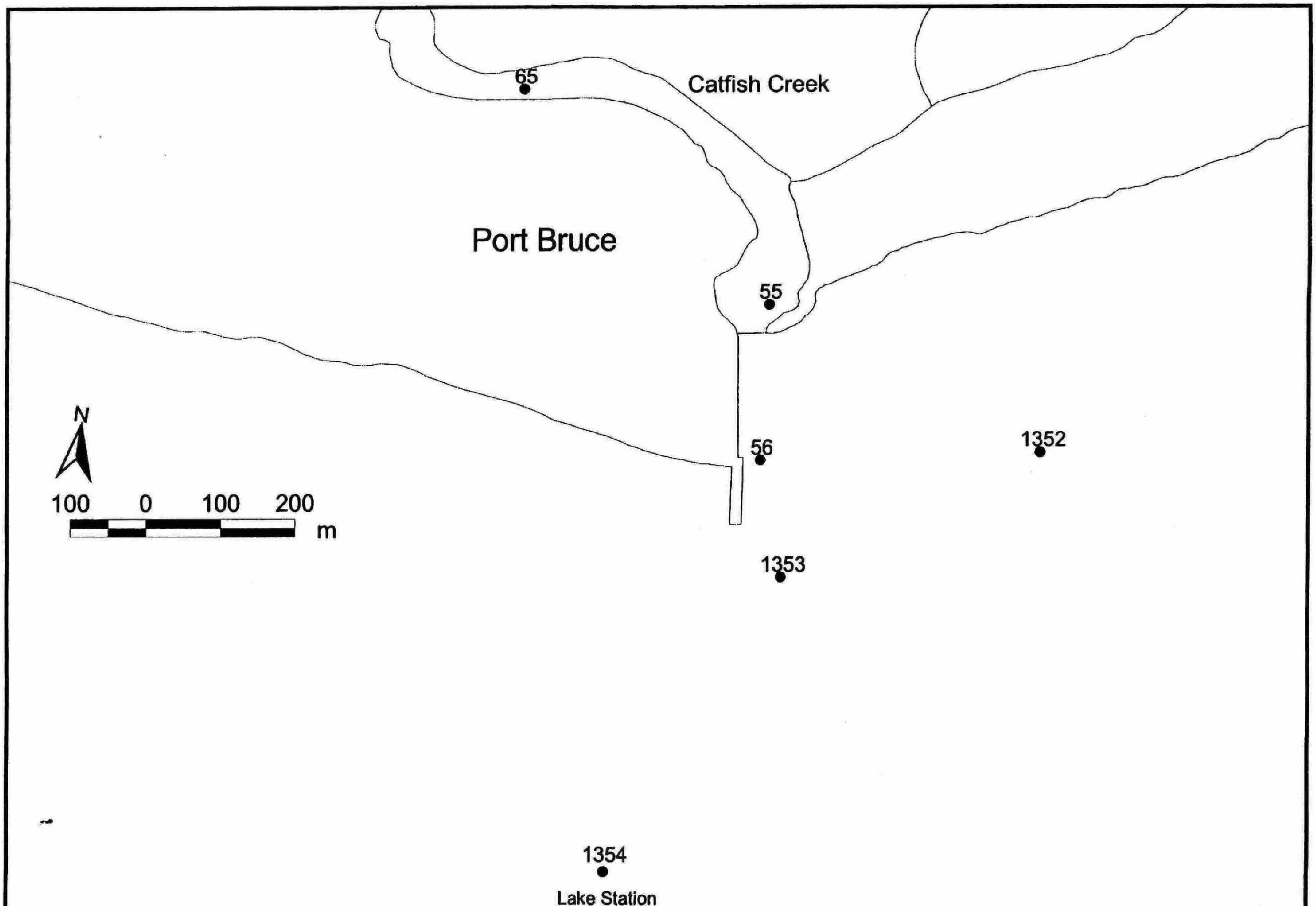


Figure 14: Port Bruce Sampling Stations

Suspended Solids

The lake station had the lowest suspended solids concentrations (spring: 4.5 mg/L; summer: 3 mg/L; fall: 21 mg/L), compared with other sites in the survey although the station was influenced by nearshore loadings in the fall. The outer harbour stations had the highest concentrations (Figure 15). Suspended solid concentrations in samples collected from the harbour stations and Catfish Creek were high for all three surveys and ranged from 15.5 to 29.5 mg/L in the spring, 11 to 72 mg/L in the summer and 30.5 to 57 mg/L in the fall. The high concentrations in the fall, particularly at the lake station may have been due to storm events and increased erosion from the clay banks along the shoreline of Lake Erie. However, Catfish Creek could also be contributing a high suspended solids load as well throughout all the surveys.

Total Phosphorus

Total phosphorus concentrations were greater than the PQWO in most samples (Table 11). In the spring and summer the lake station had the lowest phosphorus concentrations (12 *u*g/L and 8 *u*g/L respectively), while the highest concentrations were present in the Catfish Creek samples (60 *u*g/L and 144 *u*g/L respectively) (Figure 16). Since other stations had higher concentrations of suspended solids than Catfish Creek but lower TP concentrations, the high TP at the Catfish Creek station must be due in part to upstream sources and not solely due to high suspended solid concentrations. The area upstream of Port Bruce is intensively farmed (cash crops, tobacco, peanuts).

However, high TP concentrations present at the lake station in the fall were likely due to the high concentration of suspended solids since the TP concentration in Catfish Creek was lower than at the lake station (Figure 17).

Nitrogen

Total inorganic nitrogen concentrations were highest in the spring sample collections. There was a gradient from upstream to downstream with the highest concentrations present at the Catfish Creek station and the harbour mouth (range 0.39 mg/L to 3.13 mg/L) (Figure 17). The same pattern was present in the fall but concentrations of TIN were lower in general (range 0.27 to 0.47 mg/L). Summer concentrations were similar at all stations with no apparent gradient although the lowest concentrations were at the Catfish Creek site.

Concentrations of TON and TKN were low throughout the three surveys with the exception of high concentrations at the Catfish Creek site in the summer contrary to the TIN data (Figure 17). These two parameters were only weekly correlated with TIN (r=0.34). The ratio of TIN to TON suggests that most of the nitrogen present in the water in the spring was in the form of inorganic nitrogen. The high concentrations of TIN in the spring likely reflect inputs due to runoff from agricultural land. In the summer more organic nitrogen was present in the water samples than inorganic nitrogen. This relationship then fluctuates in the fall depending on the station.

Chloride and Conductivity

Chloride concentrations were similar at all stations within a survey but the highest concentrations were present in water collected from the Catfish Creek site and the harbour mouth (range: 19 to 31 mg/L) suggesting sources upstream in Catfish Creek. Chloride concentrations ranged from 14 mg/L to 17 mg/L at the outer harbour stations and the lake station during all three surveys. In general, the highest Cl concentrations were present in the spring.

Similar to the patterns for chloride, conductivity measurements were consistently higher at the harbour mouth and the Catfish Creek station for all three surveys. Conductivity ranged from 265 to 386 *u*S/cm at the outer harbour sites and from 559 to 567 *u*S/cm in Catfish Creek. In the summer and fall, conductivity values between stations followed the same pattern with the highest values upstream in the creek (Summer: range 262 to 466 *u*S/cm; fall: range 244 to 489 *u*S/cm).

Trace Metals

Concentrations of metals in all three surveys were below the PWQO with the exception of Al, Fe and Cr (Appendix D). Concentrations of Al in water samples were greater than the PWQO in all three surveys while concentrations of Fe were only greater than the objective in the summer and fall survey. Both these parameters were highly correlated with suspended solids (Al $r= 0.79$; Fe $r=0.80$ $p<0.05$). In the fall, several water samples had Cr concentrations greater than the PWQO for Cr III and Cr VI. These values were not correlated with suspended solid. However, these data should be interpreted with caution since concentrations were at trace levels.

Sediment Quality

Sediment Physical Qualities

All stations (with the exception of the lake station and the Catfish Creek station 15-65), were particularly high in sand content (>90%) and low in TOC and LOI. Sediment from the lake station was characterized as silty sand and sediment from station 15-65 was characterized as silty clay (percent sand was < 16%). The only site with TOC concentrations greater than the LEL was station 15-65 (Catfish Creek) (range from10 to 22 mg/g).

Metals and Nutrients

Since the sediment from most sites were high in percent sand, concentrations of metals and nutrients were low (all less than the LEL). The Catfish Creek station (15-65) had the highest concentration of metals in sediment. Concentrations were below the LEL for most parameters with the exception of Cr (27 *u*g/g) in one sample and Cu (range:16 to 25 *u*g/g), Mn (range: 490 to 660 *u*g/g), Ni (range: 14-20 *u*g/g), TKN (range: 0.6 to 0.9 mg/g) and TP (range: 0.62 to 0.82 mg/g). Cadmium was below the detection limit at all stations. Concentrations of metals in all sediment samples were below the Persaud et al. (1992) Great Lakes background concentrations

with the exception of Mn at station 16-65, while Fe and As were above the Mudroch et al. (1988) Lake Erie background concentration at the same station and As was above the background concentration at the lake station.

Organochlorine Pesticides and Chlorinated Benzenes

Organochlorine pesticides and chlorinated benzenes were not detected in any sediment samples.

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs were not detected in any sediment samples with the exception of one sample collected from the mouth of the harbour where trace concentrations of fluoranthene were present (40 *u*g/g).

Table 11: Concentration of nutrients, conventional parameters and bacteria in water collected from Port Bruce, 1998

Station Description	Station number			Date YYYYMMDD	Water Depth (m.)	Sample Depth (m.)	Secchi Depth (m)	Water Temp. °C	DO (field) mg/L as O	Conductivity (field) uS/cm 25 C	pH	pH (Field)	*E. coli* count/100mL	RMK	Fecal Streptococci count/100mL	RMK	*Pseudomonas aeruginosa* count/100mL	RMK	Chloride mg/L	RMK	Ammonia/ ammonium mg/L	RMK	Nitrite mg/L	RMK	Nitrite/Nitrate mg/L	RMK	Total Inorganic Nitrogen	TKN mg/L	RMK	Total Organic Nitrogen	Total Phosphorus mg/L	RMK	Suspended Solids mg/L	RMK
Spring																																		
Port Bruce-lake stn.	16	1	1354	19980428	7.5	1.5	0.9	9.0	11.4	265		8.28	2	<	2	<	0		15.6		0.002	<=W	0.004	<T	0.390		0.392	0.22		0.22	0.012		4.5	
Port Bruce-embayment	16	1	1352	19980428	2.4	1.2	0.2	9.0	11.4	285		8.08	4	<	4	<	2	<	17.0		0.002	<=W	0.016		0.660		0.662	0.30		0.30	0.040		26.0	
Split	16	1	1352	19980428	2.4	1.2	0.2	8.9	11.4	286		8.08	4	<	4	<	2	<	17.0		0.002	<=W	0.015		0.645		0.647	0.30		0.30	0.040		29.5	
Port Bruce-outside harbour	16	1	1353	19980428	4.5	1.5	0.2	9.2	11.6	265	8.11	8.06	4	<	4	<	2	<	15.6		0.002	<=W	0.007		0.380		0.382	0.22		0.22	0.022		15.5	
Port Bruce-Harbour	16	17	56	19980428	2.4	1.2	0.5	10.2	11.5	386		8.02	8		4	<	2	<	23.2		0.004	<T	0.036		1.760		1.764	0.46		0.46	0.044		23.5	
Port Bruce-Harbour	16	17	55	19980428	1.9	1.0	0.4	12.6	11.7	567		8.10	8		4		2	<	31.4		0.008	<T	0.063		3.120		3.128	0.66		0.65	0.044		16.0	
Port Bruce-Catfish Creek	16	15	65	19980428	2.3	1.1	0.5	11.4	13.6	559		8.21	4		4		2	<			0.008	<T	0.064		3.060		3.068	0.68		0.67	0.060		19.5	
Summer																																		
Port Bruce-lake stn.	16	1	1354	19980813	7.0	1.5	1.9	23.5	8.4	262	8.42	8.40	2		2	<	0		14.6		0.002	<=W	0.004	<T	0.245		0.247	0.26		0.26	0.008	<T	3.0	
Port Bruce-embayment	16	1	1352	19980813	2.1	1.0	0.6	23.3	8.4	264		8.33	6		8		0		14.8		0.002	<=W	0.006		0.240		0.242	0.24		0.24	0.016		13.0	
Port Bruce-outside harbour	16	1	1353	19980813	3.7	1.5	0.5	23.4	8.3	265		8.37	10		4		0		14.4		0.002	<=W	0.006		0.245		0.247	0.26		0.26	0.014		11.0	
Port Bruce-Harbour	16	17	56	19980813	2.1	1.0	0.1	23.8	8.3	265		8.25	20		24		2	<	14.8		0.006	<T	0.018		0.255		0.261	0.30		0.29	0.068		71.0	
Split	16	17	56	19980813	2.1	1.0	0.1	23.8	8.3	265		8.26	24		28		2	<	14.8		0.006	<T	0.019		0.250		0.256	0.28		0.27	0.070		72.0	
Port Bruce-Harbour	16	17	55	19980813	1.5	0.7	0.2	24.2	6.4	394			20		24		2	<	21.4		0.088		0.017		0.170		0.258	0.70		0.61	0.078		32.0	
Port Bruce-Catfish Creek	16	15	65	19980813	2.2	1.0	0.2	24.8	7.2	466			44		52		2		26.0		0.084		0.015		0.060		0.144	1.24		1.16	0.144		50.0	
Fall																																		
Port Bruce-lake stn.	16	1	1354	19981022	6.6	1.5	0.5	13.1	10.3	244		8.12	12		4	<	2	<	13.8		0.018		0.013		0.255		0.273	0.24		0.22	0.036		21.0	
Port Bruce-embayment	16	1	1352	19981022	1.4	0.7	0.2	12.7	10.3	249		8.08	20	<=>	10	<=>	4	<	14.0		0.012		0.017		0.265		0.277	0.40		0.39	0.070		55.0	
Split	16	1	1352	19981022	1.4	0.7	0.2	12.7	10.3	248		8.08	20	<=>	10	<=>	4	<	14.0		0.014		0.013		0.260		0.274	0.40		0.39	0.070		57.0	
Port Bruce-outside harbour	16	1	1353	19981022	3.6	1.5	0.2	12.8	10.3	244	8.15	8.07	20	<=>	10	<=>	4	<	13.8		0.012		0.017		0.260		0.272	0.30		0.29	0.050		43.5	
Port Bruce-Harbour	16	17	56	19981022	1.5	0.7	0.2	11.6	10.0	295		7.99	20	<=>	20	<=>	4	<	14.8		0.024		0.015		0.285		0.309	0.40		0.38	0.060		39.0	
Port Bruce-Harbour	16	17	55	19981022	0.9	0.4	0.4	10.8	9.3	451		7.88	24		20		2	<	19.0		0.066		0.009		0.390		0.456	0.44		0.37	0.056		31.5	
Port Bruce-Catfish Creek	16	15	65	19981022	1.8	0.9	0.4	10.5	9.4	489		7.96	20	<=>	20	<=>	4	<	19.6		0.070		0.009		0.400		0.470	0.22		0.15	0.022		30.5	
Port Bruce-Catfish Creek (F-blank)	16	15	65	19980428															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.02	<=W	0.02	0.002	<=W	0.5	<T
Port Bruce-Catfish Creek (F-blank)	16	15	65	19980813															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.02	<=W	0.02	0.002	<=W	0.5	<W
Port Bruce-Catfish Creek (T-blank)	16	15	65	19980810															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.02	<=W	0.02	0.002	<=W	0.5	<W
Port Bruce-Catfish Creek (F-blank)	16	15	65	19981022															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.02	<=W	0.02	0.002	<=W	0.5	<W
Port Bruce-Catfish Creek (T-blank)	16	15	65	19981019															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.02	<=W	0.02	0.002	<=W	0.5	<W

<W no measurable response
<T measurable trace amount, interpret with caution
<=> approximate value
F-blank field blank
T-blank travel blank

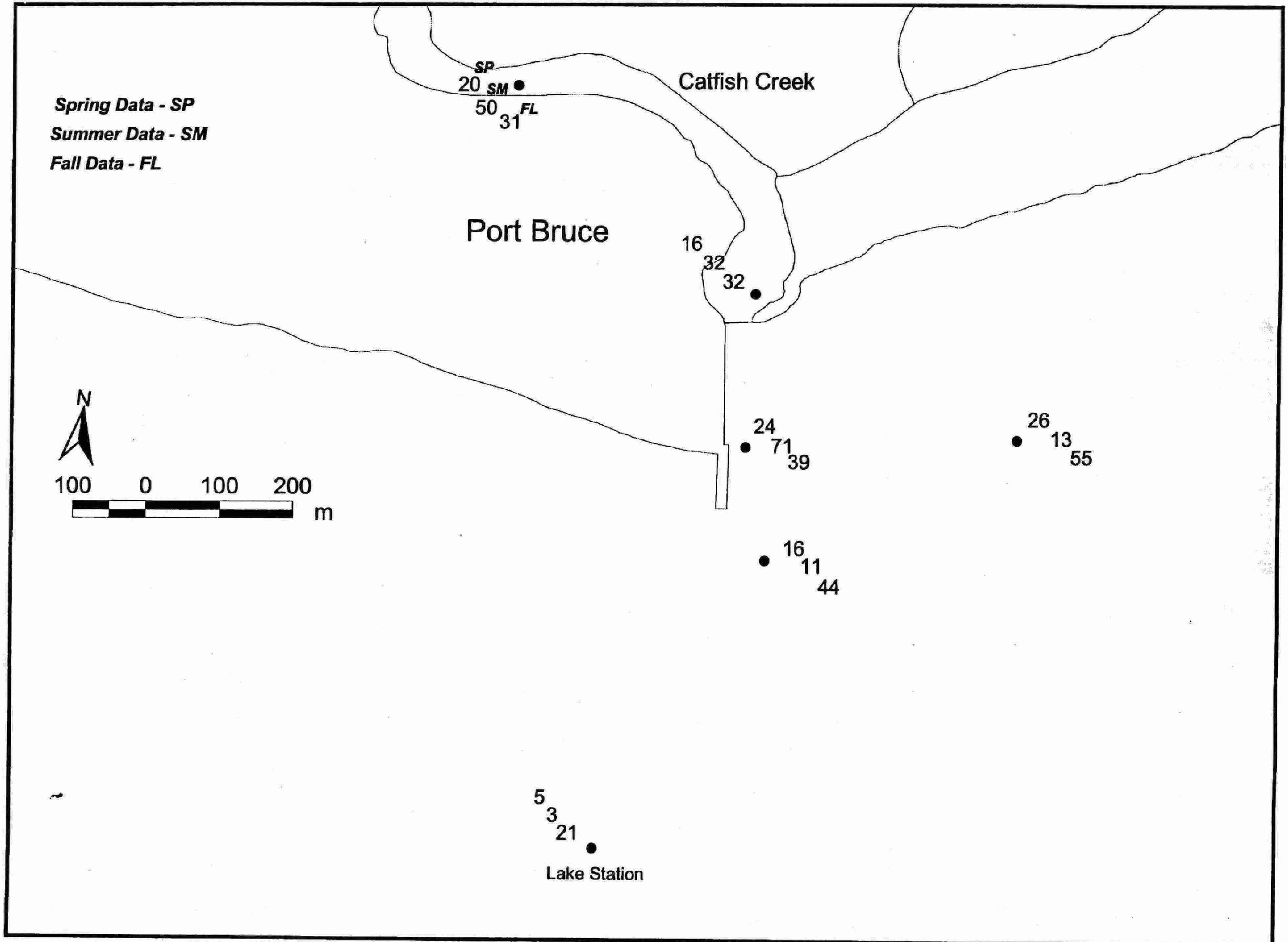


Figure 15: Spring, Summer & Fall Suspended Solids Concentrations (mg/L), Port Bruce, 1998

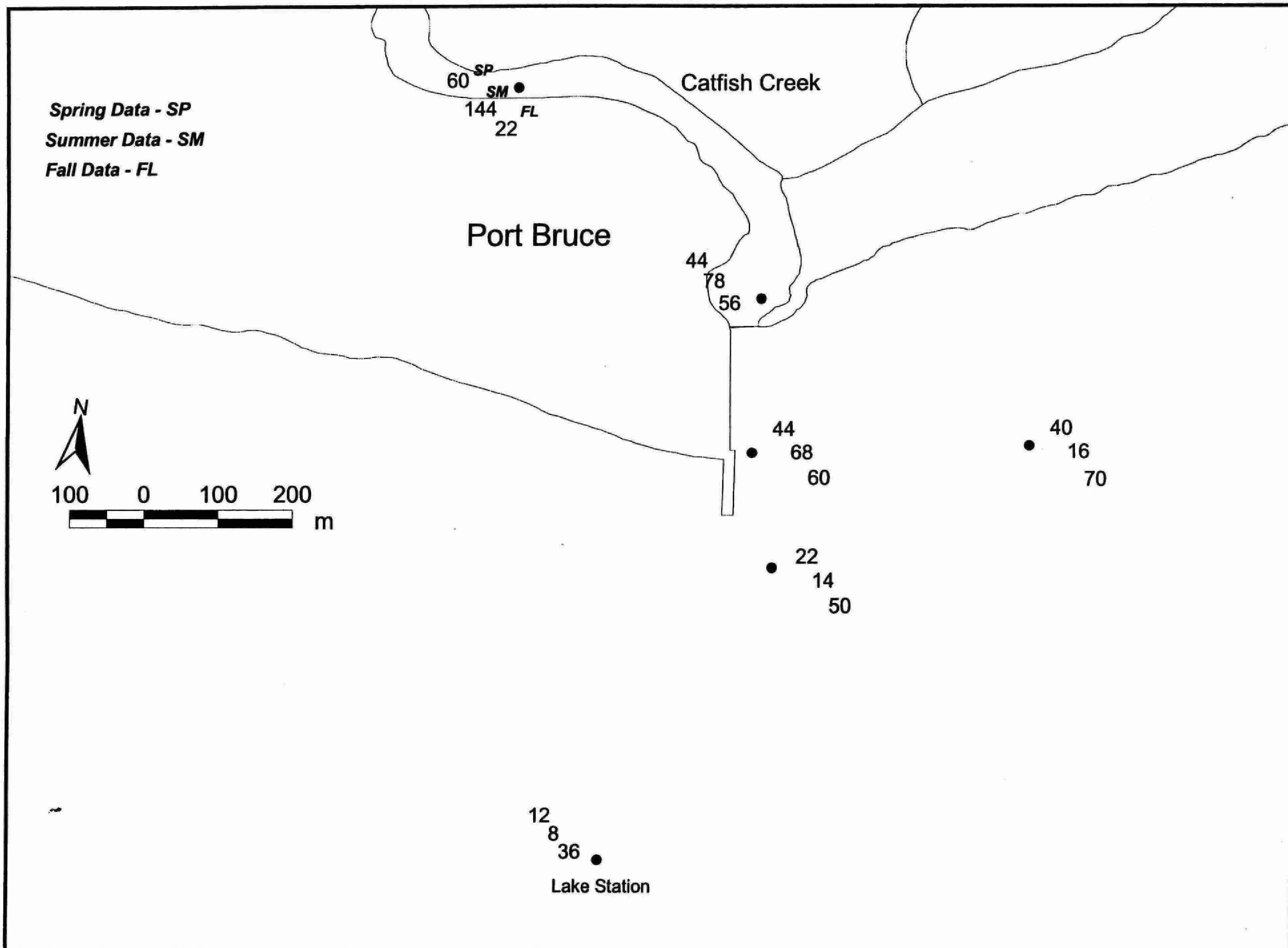


Figure 16: Spring, Summer & Fall Total Phosphorus Concentrations (ug/L), Port Bruce, 1998

Figure 17: Water quality parameters in Surface grab samples - Port Bruce and Catfish Creek, 1998

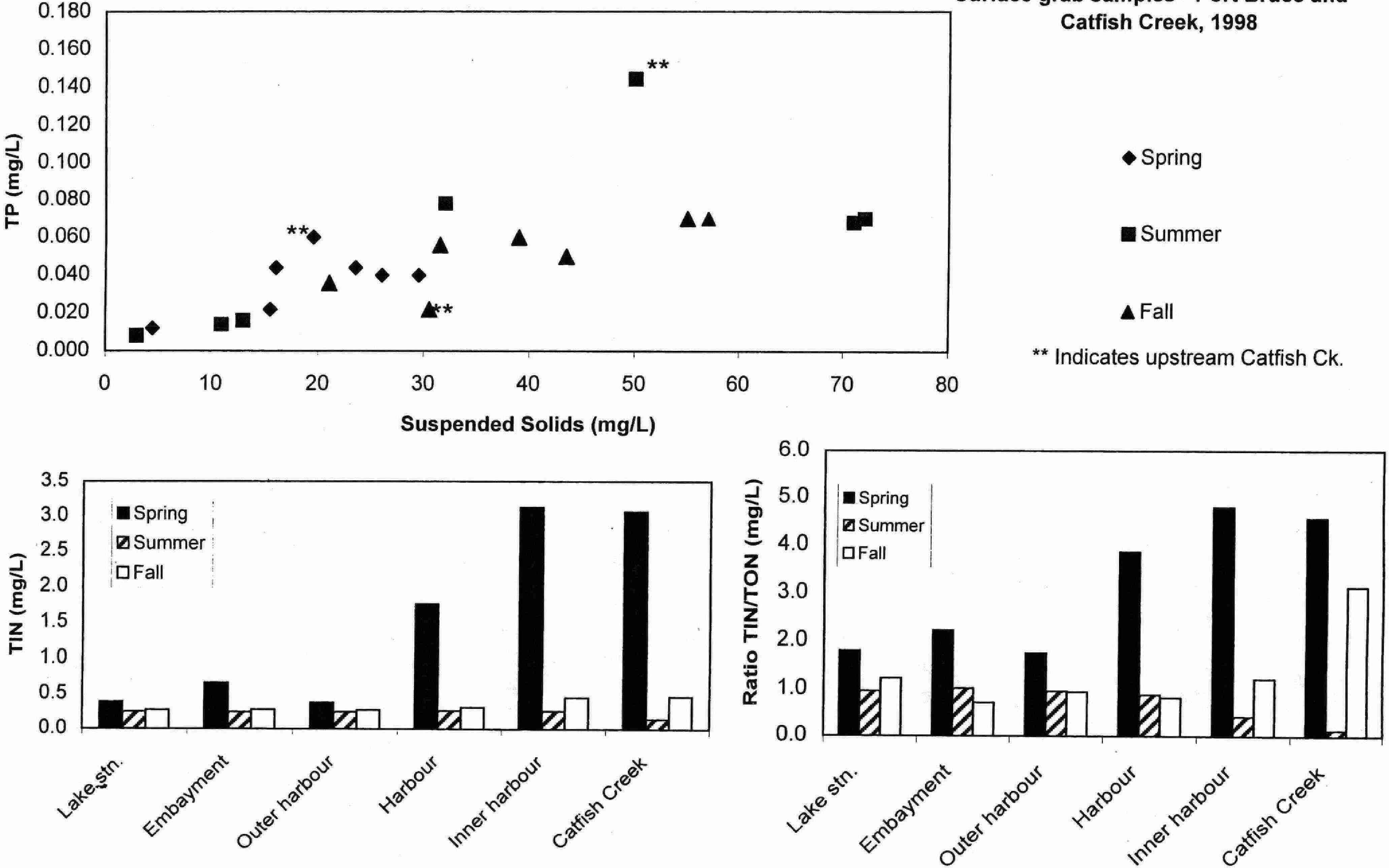


Table 12: Concentrations of nutrients, conventional parameters and metals in sediment collected from Port Bruce, 1998

Station Description	Station Number		Date YYYYMMDD	Sample Depth (m)	Aluminum ug/g	Arsenic ug/g	RMK	Cadmium ug/g	RMK	Chromium ug/g	Copper ug/g	RMK	Iron ug/g	Mercury ug/g	RMK	Manganese ug/g	Nickel ug/g	Lead ug/g	RMK	Zinc ug/g	RMK	TKN mg/g	RMK	Total Phosphorus mg/g	Loss on Ignition (mg/g)	RMK	TOC (mg/g)	RMK	Clay %	RMK	Silt %	RMK	Sand %	RMK
Port Bruce-lake stn.	1	1354	19980813	7	5500	2.4		0.2	<=W	10	10		11000	0.08		380	7.0	3	<T	25		0.5		0.74	7		3	<T	11		43		46	
	1	1354	19980813	7	5200	2.4		0.2	<=W	9	10		9700	0.02	<T	360	6.6	5	<T	23	<T	0.1	<=W	0.58	8		8		10		42		48	
	1	1354	19980813	7	5200	2.4		0.3	<T	9	9		9800	0.02	<T	370	5.9	5	<T	21	<T	0.1	<=W	0.64	7		4	<T	9		40		51	
Port Bruce-embayment	1	1352	19980813	2.1	3100	1.0		0.2	<=W	10	4	<T	10000	0.01	<=W	240	4.0	2	<=W	21	<T	0.1	<=W	0.58	3		2	<T	1	<T	2	<T	98	
	1	1352	19980813	2.2	3100	1.1		0.2	<=W	8	4	<T	7700	0.01	<=W	210	3.8	2	<=W	25		0.1	<=W	0.36	3		1	<=W	1	<T	2	<T	97	
	1	1352	19980813	2.1	3000	1.0		0.3	<T	12	6		16000	0.01	<=W	260	2.8	2	<=W	33		0.1	<=W	0.66	3		1	<=W	1	<T	2	<T	97	
Port Bruce-outside harbour	1	1353	19980813	3.4	3300	1.6		0.3	<T	6	7		6900	0.02	<T	230	4.3	2	<=W	25		0.1	<=W	0.28	4		1	<=W	0	<T	1	<=W	97	
	1	1353	19980813	3.4	3400	1.6		0.2	<=W	6	7		7900	0.01	<=W	240	4.1	2	<=W	22	<T	0.2	<T	0.32	3		1	<=W	1	<T	2	<T	96	
	1	1353	19980813	3.4	3000	1.5		0.3	<T	6	5		7700	0.02	<T	220	4.2	2	<=W	19	<T	0.1	<=W	0.46	2	<T	2	<T	1	<T	2	<T	97	
Port Bruce-Harbour	17	56	19980813	2	3000	1.0		0.2	<=W	6	4	<T	5400	0.01	<=W	200	4.3	4	<T	15	<T	0.1	<=W	0.24	2	<T	1	<=W	1		5		94	
	17	56	19980813	2	3000	1.1		0.2	<=W	6	4	<T	5900	0.01	<=W	210	4.0	2	<=W	24	<T	0.1	<=W	0.36	5		4	<T	2		5		92	
	17	56	19980813	2	3000	1.0		0.2	<=W	6	3	<T	6600	0.01	<=W	220	3.6	2	<=W	22	<T	0.1	<=W	0.34	5		4	<T	1	<T	3	<T	95	
Port Bruce-Harbour	17	55	19980813	1.5	2800	0.5	<T	0.2	<=W	8	2	<T	5400	0.02	<T	180	3.5	2	<=W	10	<T	0.1	<=W	0.24	3		3	<T	1	<T	2	<T	97	
	17	55	19980813	1.4	3000	0.8	<T	0.2	<=W	7	2	<T	6000	0.01	<=W	190	3.4	2	<=W	10	<T	0.1	<=W	0.24	2	<T	1	<=W	1	<T	2	<T	97	
	17	55	19980813	1.5	2800	0.8	<T	0.2	<=W	8	2	<T	5600	0.02	<T	180	4.1	2	<=W	11	<T	0.1	<=W	0.24	2	<T	2	<T	0	<T	2	<T	97	
Port Bruce-Catfish Creek	15	65	19980813	1.5	13000	2.6		0.3	<T	19	16		16000	0.02	<T	490	14.0	11		49		0.6		0.62	28		12		15		29		57	
	15	65	19980813	2	19000	4.2		0.4	<T	27	25		22000	0.03	<T	660	20.0	15		74		0.9		0.78	36		22		36		59		4	<T
split	15	65	19980813	2.7	17000	3.4		0.2	<=W	23	20		19000	0.03	<T	560	18.0	11		61		0.6		0.82	31		10		33		51		16	
split	15	65	19980813	2.7	18000	3.6		0.4	<T	25	20		20000	0.04	<T	580	17.0	11		62		0.6		0.76	32		14		34		53		14	
Lowest Effect Level (ug/g)						6		0.6		26	16		20000	0.2		440	16	31		120		0.55 mg/g		0.6 mg/g			10 mg/g							
Severe Effect Level (ug/g) **						33		10		110	110		40000	2		1100	75	250		820		4.8 mg/g		2.0 mg/g			100 mg/g							
Background - Great Lakes pre-colonial sediment horizon, Persaud et al. (1992)						4.2		1.1		31	25		31000	0.1		400	31	23		65														
Background - Lake Erie pre-colonial sediment horizon for Harbours (H) and/or depositional zones (D), Mudroch et al. (1988)						0.5-1.2 (H)		0.1 (H) 0.1-1.7(D)		30-250(H) 9-25(D)	10-110(H) 20-48(D)		1000-15000(H) 8900-48200(D)	0.05-7(H)			55-65(H) 10-76(D)	21-49(D)		40-500(H) 8-128(D)														

<W no measurable response

<T measurable trace amount, interpret with caution

<=> approximate value

PORT STANLEY

Port Stanley is located at the mouth of Kettle Creek. The WPCP for municipal sewage for Port Stanley discharges to Kettle Creek. This plant has secondary treatment. The creek flows through some agricultural land (mainly mixed farming: livestock and cash crops), and through both urban and rural developments. The WPCP for the town of St. Thomas (population of about 35,000) located about 20 km upstream of Port Stanley also discharges to the creek. The Ford Motor Company discharges to Dodge Creek which flows into Kettle Creek about 30 km upstream of the harbour. There are numerous storm sewers that discharge to the creek and harbour. Imperial Fuels, Sterling Fuels and a former gasification plant (Shamrock Chemical) were located along the creek but these facilities are no longer in operation and have been decommissioned to varying degrees. Deposits of buried oil-tar waste were located and removed from an area downstream of the first bridge (upstream of the harbour), but there have been no clean up activities planned for the area upstream of the bridge. There is an oil tank storage area located in the port. The harbour was dredged in 1987 for navigational purposes.

Mean daily discharge measurements for Kettle Creek are in Appendix A. The mean daily discharged for 1998 ranged from 0.1 to 92.7 m^3/sec measured at the St. Thomas gauging station (ID 02GC002). The flow in Kettle Creek during sampling on April 28 was 1.4 m^3/sec although flow measurements were higher during the two weeks prior to the survey. During the summer and fall survey the flow for Kettle Creek was estimated at 0.2 m^3/sec on both sampling days.

Five stations were sampled for water and sediment (Figure 18). One station was located in Kettle Creek (15-66) and three stations were located in the harbour. One of the harbour stations was placed near a storm sewer (17-57). In addition, there was one station located in an embayment to the east of the harbour and one lake station located (station 1-1356) about 1.4 km from the harbour mouth.

All water and sediment data are provided in Table 13 to 15 and Figures 19 to 21 following the description and interpretation of the data for Port Stanley.

Water Quality

Water temperature was consistent at all stations for each season sampled. Water temperature ranged from 8.3 to 10.1 °C in the spring, 23.7 to 24.7 °C in the summer and 14.7 to 15.1 °C in the fall. Dissolved oxygen was also consistent between sampling sites with the lowest concentrations in Kettle Creek in the summer (range: spring 10.2 to 11.8 mg/L; summer 5.8 to 8.3 mg/L; fall 8.6 to 9.4 mg/L). The deepest Secchi disc depth readings were consistently present at the lake station (range for three surveys: 0.5 to 1.9 m) compared with the other sites where readings were typically less than 0.5 m. Poor water clarity was likely due to high suspended solid loadings particularly in the fall.

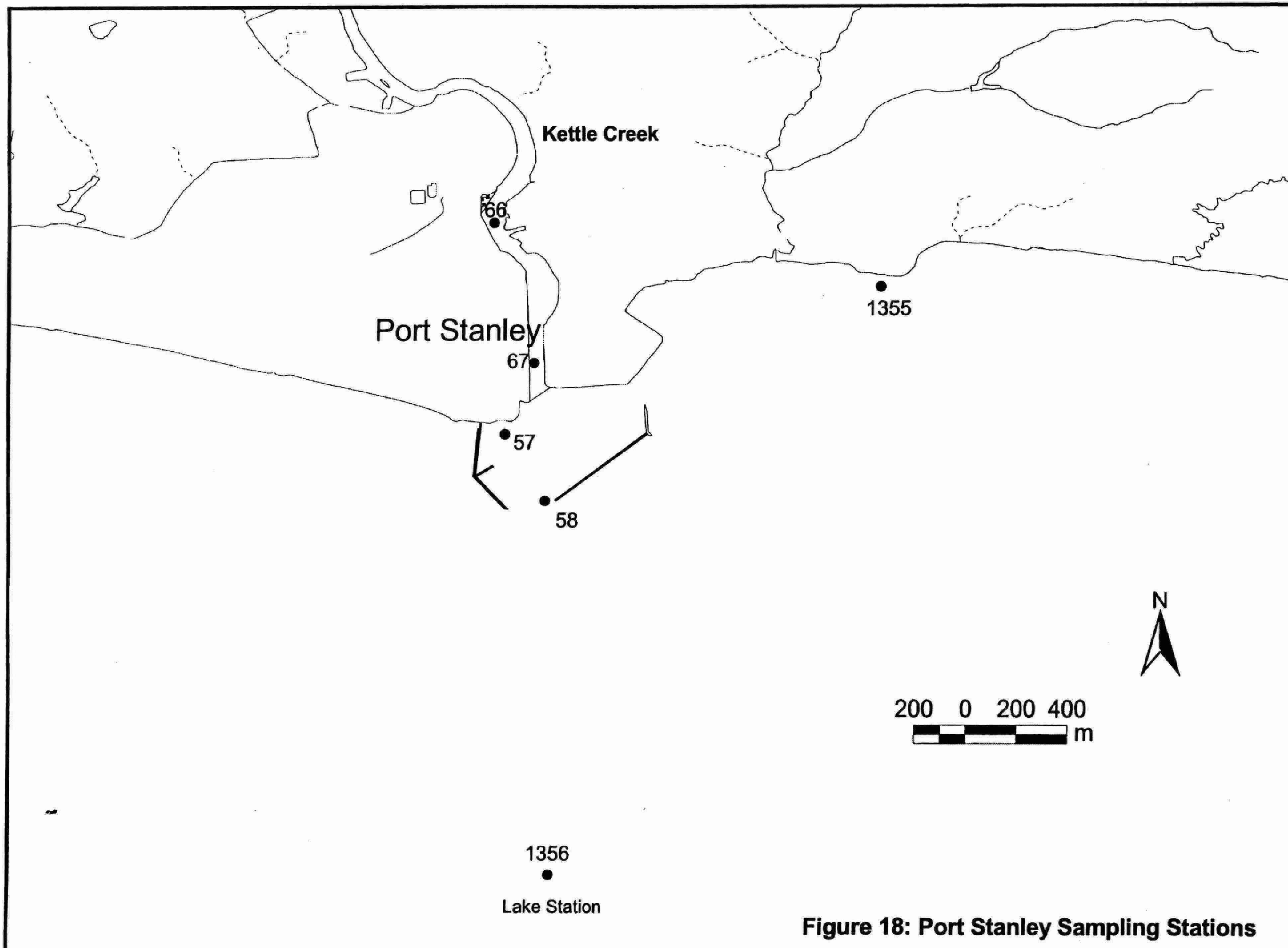


Figure 18: Port Stanley Sampling Stations

Suspended Solids

The highest suspended solids concentrations were present in samples collected in the fall (range 10.0 mg/L to 126.0 mg/L). In general, suspended solid concentrations in spring at most stations were similar to the summer (range: 2 mg/L to 42 mg/L and 3 mg/L to 62 mg/L respectively). A downstream gradient with the highest concentrations present upstream in Kettle Creek was evident in the spring and summer surveys suggesting sources of suspended solids upstream in Kettle Creek (Figure 19). However, in the fall, the highest suspended solids concentrations were present in the samples collected from the harbour and embayment stations while concentrations decreased at the inner harbour site and the upstream Kettle Creek site. Although during the fall survey, the lowest concentration of suspended solids was present at the lake site (10 mg/L), this high loading and the high concentrations at the embayment station (126 mg/L) and outer harbour sites (109 mg/L) suggest erosion from the bluffs along the Lake Erie banks in the vicinity of the harbour as the source of suspended solids. Increased erosion was likely due to storm events just prior to sampling.

Bacteriological Analysis

Bacterial contamination was low in the spring with all counts below the provincial recreational guideline. In the summer bacterial levels were low at the outer harbour station and lake station but concentrations were above the provincial guideline (100 counts/100 mL) at the site in the harbour located near a storm sewer (station 17-57), and at the two upstream sites in Kettle Creek (15-66, 15-67) suggesting sources of bacteria in Kettle Creek. There was a downstream gradient with the highest contamination upstream (Figure 20).

The highest bacteria counts in general were present in the fall. With the exception of the Lake Erie station, all stations had water with bacteria counts greater than the provincial guidelines (*E. Coli* - range from 110 to 560 counts/ 100 mL and fecal strep - range from 70 to 440 counts/100 mL). The highest contamination was present at station 17-67 located near the storm sewer and a downstream gradient was evident moving towards the Lake Erie station. The upstream Kettle Creek station had bacteria levels that were greater than the guideline but lower than the mid harbour site. This data suggest a possible source of bacterial contamination in the harbour at the storm sewer in addition to upstream sources.

Total Phosphorus

The highest TP concentrations in water were present in the fall (lake station: 20 *u*g/L; range at remaining stations: 90 to 150 *u*g/L). The PWQO was exceeded at all stations in the fall and at most stations in the spring and summer suggesting eutrophic conditions. A downstream gradient was evident in all three surveys with the highest concentrations of TP present in water collected from the upstream Kettle Creek station suggesting upstream sources of phosphorus. However, TP concentrations were quite similar among all harbour and creek stations in the fall likely due to

the mixing of Lake Erie water with creek water and the high suspended solids concentrations in Lake Erie. TP concentrations were correlated with suspended solids (r=0.85)(figure 21).

Nitrogen

TIN concentrations were highest in the spring samples (Figure 21). Concentrations were generally lowest in the fall survey with the exception of the Kettle Creek site which had similar TIN concentrations in summer and fall. Data from all three surveys showed a downstream gradient with the highest concentrations present in Kettle Creek. The influence of creek water quality on Lake Erie nearshore conditions was evident from the spring TIN data.

Nitrate-nitrite concentrations were high in general and suggest contamination likely from agricultural practices. The ratio of TIN to TON showed that most of the nitrogen in the system was in the form of inorganic nitrogen in the spring and summer which also suggests contributions from agricultural practices. Inorganic nitrogen concentration were three to four times greater than organic nitrogen in the spring and two to three times higher in the summer.

Chloride and Conductivity

Chloride concentrations and conductivity exhibited a downstream gradient in each survey with the highest concentrations in water collected from Kettle Creek. Chloride concentrations in water were highest in the spring (range 16 to 49 mg/L) and were in general, similar throughout the summer and fall surveys (range 14 to 39 mg/L). Conductivity gradually decreased over the three surveys with the highest concentrations in the spring and lowest concentrations in the fall (range Spring - 265 to 642 *u*S/cm; Summer - 264 to 470 *u*S/cm; Fall - 247 to 364 *u*S/cm) following the same pattern as Cl.

Trace Metals

Concentrations of metals in water in all three surveys were below the PWQO with the exception of Al, Fe and Cr. Concentrations of Al were greater than the PWQO in all three surveys while Fe was greater than the objective in the summer and fall survey at most stations and only at the upstream Kettle Creek station in the spring. Both these parameters were correlated with suspended solids suggesting that the extremely high concentrations in some samples may be due to a high sediment content in the water (Al r=0.70; Fe r=0.95). Water samples with Cr concentrations greater than the PWQO for Cr III and Cr VI in the summer and fall surveys should be interpreted with caution since concentrations were at trace levels and suspended solids were high. Cr was correlated with suspended solids (r=0.75).

Sediment Quality

Sediment Physical Qualities

Sediment stations within Kettle Creek (station 15-66 and 15-67) were high in clay and silt (> 80%) as was station 17-58 at the mouth of the harbour while the station in the embayment to the east of Port Stanley was characterized as silty sand. Station 17-57 which was located near a storm sewer within the harbour had a higher sand content than the other stations (range in percent sand was 19 to 28%), which may have effected the metal and nutrient concentrations at that site. The Port Stanley lake station had sediment with high coarse sand content (between 1000 to 2000 *u*m - 34%). TOC concentrations were greater than the LEL at most stations and were weakly correlated with particle size (r=0.56).

Metals and Nutrients

Sediment concentrations of As, Cd, Hg and Pb were below the LEL at all stations with only one exception: 15 *u*g/g As was detected in samples collected from the Port Stanley lake station (station 1-1356). This was particularly noteworthy given the high sand content at this station. The Great Lakes background concentration for As is 4.2 *u*g/g (Persaud et al. 19992) and the Lake Erie background concentration for harbours ranges from 0.5 to 1.2 (Mudroch et al. 1988). Notwithstanding the As data, the highest concentrations for all parameters were found in sediment collected from stations 15-66 and 15-67 located in Kettle Creek and the inner harbour. Copper, Cr, Fe, Mn and Ni were greater than the LEL at these two stations. Copper also exceeded the LEL at station 17-58.

TKN was less then the detection limit at all sites with the exception of station 15-66 and 15-67 where concentrations in sediment were greater than the LEL suggesting nutrient enrichment in the creek sediment. Total phosphorus concentrations were also greater than the LEL at stations 15-66, 15-67, 17-57 and 17-58. Although concentrations were generally higher at stations within Kettle Creek, data corrected for particle size by normalizing the concentrations to Al showed enrichment of some parameters (Fe, Mn and TP) at the mouth of the harbour compared with the stations in Kettle Creek. With the exception of As and Mn and a few samples analysed for Zn and Fe, metal concentrations were generally less than the Lake Erie and/or Great Lakes background concentrations (Mudroch et al. 1988; Persaud et al. 1992).

Organochlorine Pesticides and Chlorinated Benzenes

Organochlorine pesticides and chlorinated benzenes were not detected in any sediment samples with the exception of trace concentrations of DDE at stations 15-66 and 15-67 (range: 3 to 5 ng/g).

Polycyclic Aromatic Hydrocarbons (PAHs)

With only few exceptions, PAH were only detected in sediment samples collected from stations 15-66 and 15-67. Almost all PAH compounds tested were present in sediment at trace concentrations with the exception of fluoranthene, naphthalene, pyrene and phenanthrene which were present at concentrations that ranged up to 180 ng/g. Total PAH concentrations at station 15-66 ranged from 900 to 1220 ng/g while concentrations ranged from 660 to 720 ng/g at station 15-67. These values were all less than the LEL.

Table 13: Concentration of nutrients, conventional parameters and bacteria in water collected from Port Stanley, 1998

Station Description	Station number			Date YYYYMMDD	Water Depth (m)	Sample Depth (m)	Secchi Depth (m)	Water Temp °C	DO (field) mg/L as O	Conductivity (field) uS/cm 25 C	pH	pH (Field)	*E. coli* count/100mL	RMK	Fecal Streptococci count/100mL	RMK	*Pseudomonas aeruginosa* count/100mL	RMK	Chloride mg/L	RMK	Ammonia/ ammonium mg/L	RMK	Nitrite mg/L	RMK	Nitrite/Nitrate mg/L	RMK	Total Inorganic Nitrogen	TKN mg/L	RMK	Total Organic Nitrogen	Total Phosphorus mg/L	RMK	Suspended Solids mg/L	RMK
Spring																																		
Port Stanley-lake stn	16	1	1356	19980428	11.2	1.5	1.9	8.3	11.8	265		8.10	2	<	2	<	0		15.6		0.002	<=W	0.003	<T	0.420		0.422	0.22		0.22	0.012		2.0	<T
Port Stanley-embayment	16	1	1355	19980428	2.7	1.4	0.5	9.0	11.3	277		8.11	4	<	4	<	2	<	16.4		0.002	<=W	0.007		0.530		0.532	0.24		0.24	0.022		12.0	
Port Stanley-Harbour	16	17	58	19980428	7.6	1.5	0.5	8.7	11.2	316		8.08	4		4		2	<	20.8		0.022		0.014		1.020		1.042	0.36		0.34	0.036		15.5	
Split	16	17	58	19980428	7.5	1.5	0.5	8.8	11.1	323		8.07	12		4	<	2	<	21.0		0.020		0.015		1.010		1.030	0.34		0.32	0.034		14.0	
Port Stanley-Harbour at storm sewer	16	17	57	19980428	2.2	1.1	0.4	9.1	10.9	340		8.12	4		4		2	<	21.8		0.030		0.016		1.150		1.180	0.40		0.37	0.044		18.0	
Port Stanley-Kettle Creek	16	15	67	19980428	6.7	1.5	0.4	10.1	10.2	488		8.09	36		8		2	<	35.2		0.074		0.037		2.540		2.614	0.76		0.69	0.076		30.0	
Port Stanley-Kettle Creek (upstream)	16	15	66	19980428	2.6	1.3	0.2	9.9	10.9	642	8.24	8.23	20		16		2		48.8		0.028		0.045		3.990		4.018	0.84		0.81	0.096		42.0	
Summer																																		
Port Stanley-lake stn	16	1	1356	19980811	10.8	1.5	1.6	24.1	8.3	264		8.53	2	<	2	<	0				0.002	<=W	0.007		0.250		0.252	0.26		0.26	0.008	<T	3.0	
Port Stanley-embayment	16	1	1355	19980811	2.0	0.9	1.1	24.1	7.3	264		8.29	26		6		0		14.4		0.022		0.007		0.275		0.297	0.30		0.28	0.012		6.0	
Port Stanley-Harbour	16	17	58	19980811	7.0	1.5	0.3	24.2	6.9	294		8.01	36		72		4		17.8		0.054		0.016		0.705		0.75[illegible]	0.40		0.35	0.048		24.0	
Port Stanley-Harbour at storm sewer	16	17	57	19980811	2.0	1.0	0.3	23.7	6.8	281		8.07	124		104		4		16.6		0.068		0.014		0.615		0.683	0.40		0.33	0.042		19.5	
Port Stanley-Kettle Creek	16	15	67	19980811	6.1	1.5	0.1	24.2	6.1	336		7.83	168		60		2		23.4		0.082		0.025		1.140		1.222	0.58		0.50	0.096		47.5	
Port Stanley-Kettle Creek (upstream)	16	15	66	19980811	2.4	1.2	0.1	24.6	5.8	470		7.77	220		188		4		39.2		0.076		0.037		2.210		2.286	0.76		0.68	0.140		59.5	
Split	16	15	66	19980811	2.4	1.2	0.1	24.7	5.8	445		7.78	184		196		6		39.2		0.076		0.037		2.120		2.196	0.76		0.68	0.140		62.0	
Fall																																		
Port Stanley-lake stn	16	1	1356	19981019	10.8	1.5	0.5	15.1	9.3	247		8.13	4		2	<	0		13.6		0.018		0.004	<T	0.220		0.238	0.26		0.24	0.020		10.0	
Port Stanley-embayment	16	1	1355	19981019	2.5	1.1	0.1	15.1	9.4	246		8.12	110		90	<=>	4	<	14.2		0.020		0.014		0.230		0.250	0.40		0.38	0.130		126.0	
Port Stanley-Harbour	16	17	58	19981019	6.8	1.5	0.1	14.9	9.4	248		8.10	310		260		4	<	14.6		0.022		0.026		0.280		0.302	0.40		0.38	0.120		109.0	
Port Stanley-Harbour at storm sewer	16	17	57	19981019	1.6	0.8	0.1	14.8	9.3	252		8.07	520		440		4	<	15.2		0.050		0.027		0.365		0.415	0.50		0.45	0.130		107.0	
Split	16	17	57	19981019	1.6	0.8	0.1	14.8	9.3	252		8.10	530		430		4	<	14.8		0.046		0.032		0.380		0.426	0.50		0.45	0.130		117.0	
Port Stanley-Kettle Creek	16	15	67	19981019	6.1	1.5	0.1	14.8	8.9	293		7.99	560		420		4	<	17.4		0.060		0.028		0.730		0.790	0.50		0.44	0.090		79.5	
Port Stanley-Kettle Creek (upstream)	16	15	66	19981019	2.2	1.1	0.2	14.7	8.6	364		7.92	160		70	<=>	6		30.6		0.102		0.064		2.480		2.582	0.70		0.60	0.150		57.5	
Port Stanley-Kettle Creek (F-blank)				19980811															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.02	<=W	0.02	0.002	<=W	0.5	<W
Port Stanley-Kettle Creek (F-blank)				19981019															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.02	<=W	0.02	0.002	<=W	0.5	<W

<W no measurable response
<T measurable trace amount, interpret with caution
<=> approximate value
F-blank field blank
T-blank travel blank

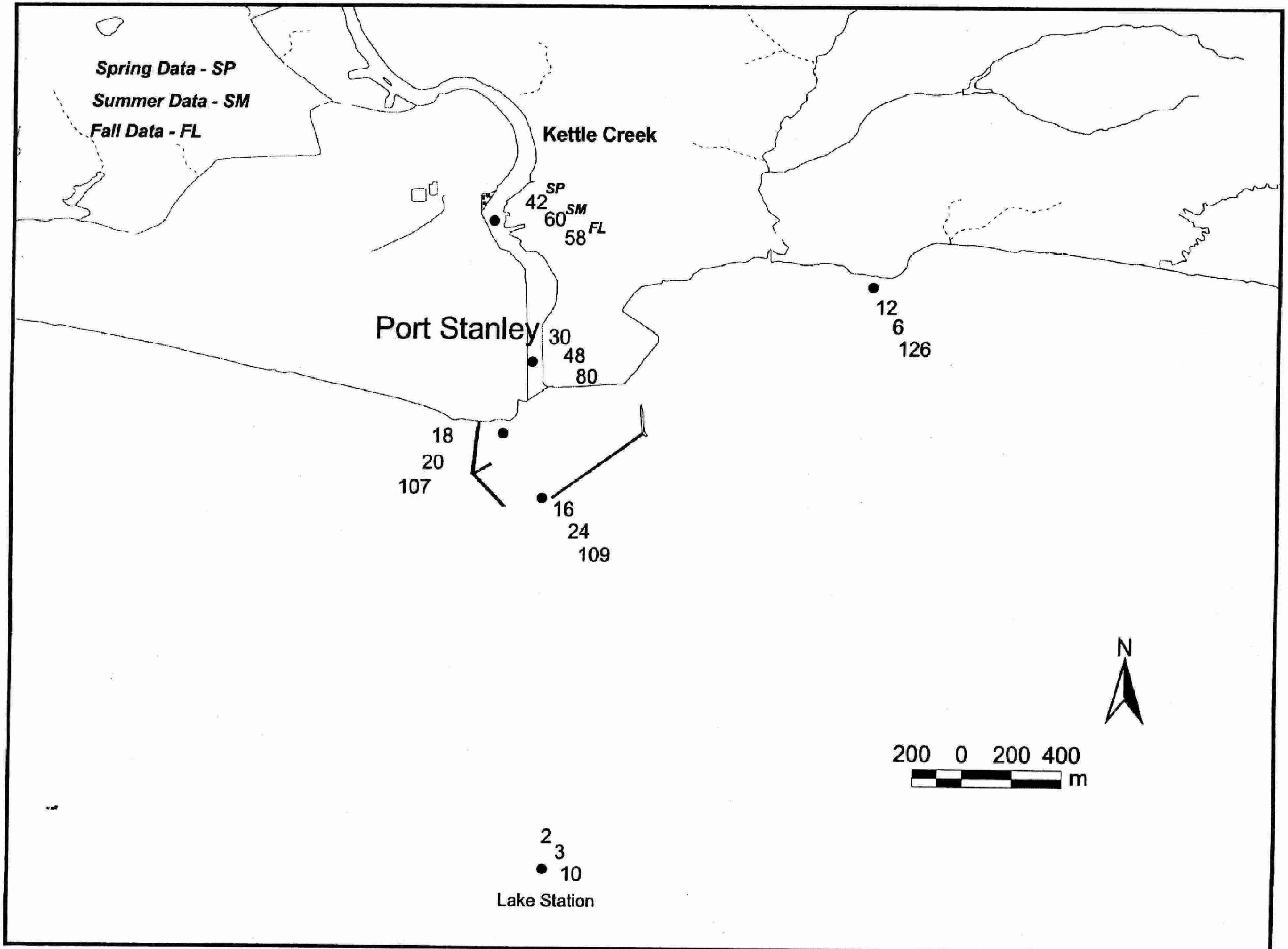


Figure 19: Spring, Summer & Fall Suspended Solids Concentration (mg/L), Port Stanley, 1998

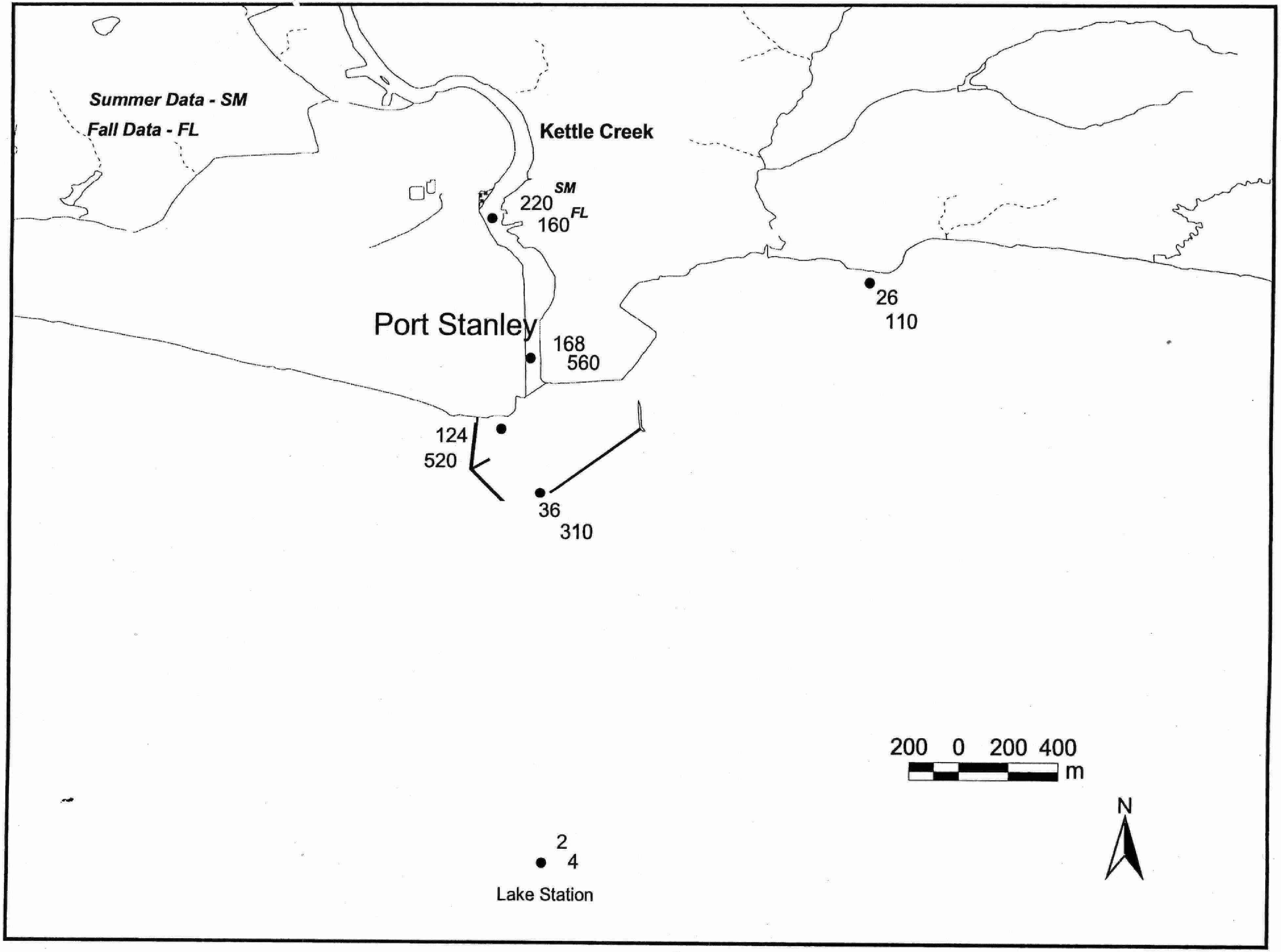
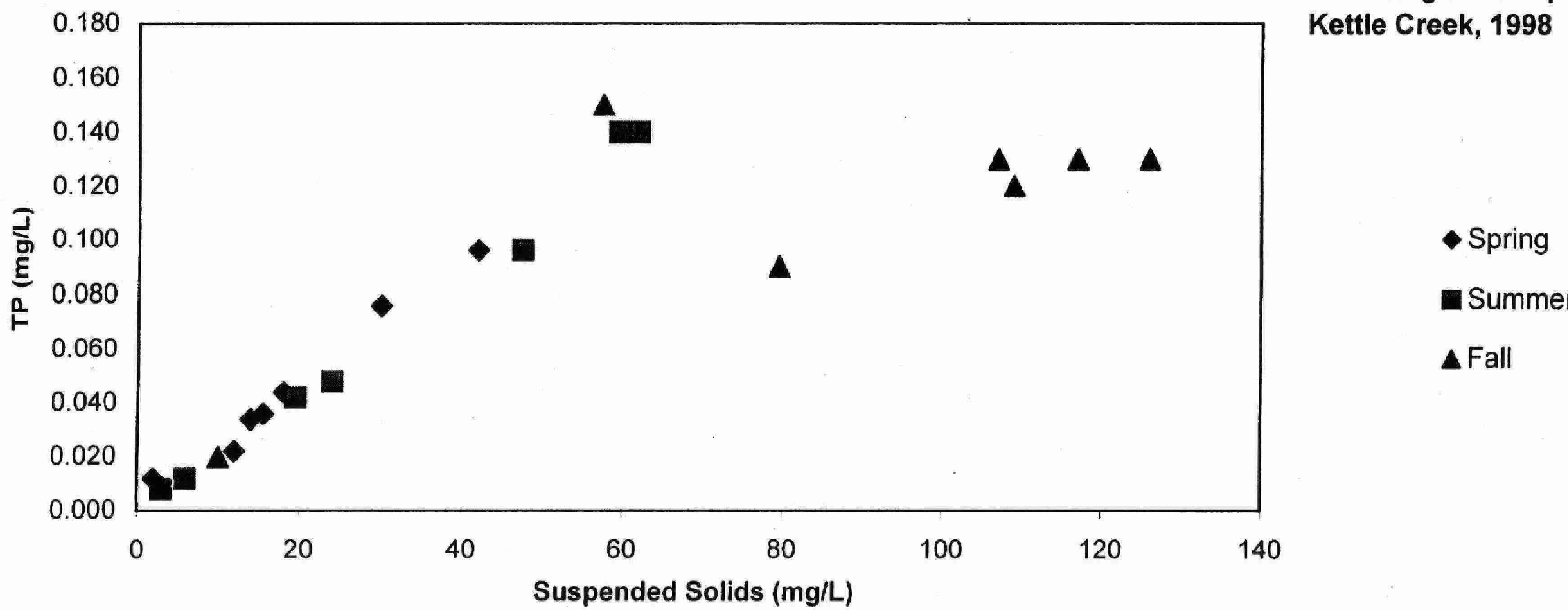


Figure 20: Summer & Fall E. coli Contamination (counts/100 mL), Port Stanley, 1998

Figure 21: Water quality parameters in Surface grab samples - Port Stanley and Kettle Creek, 1998



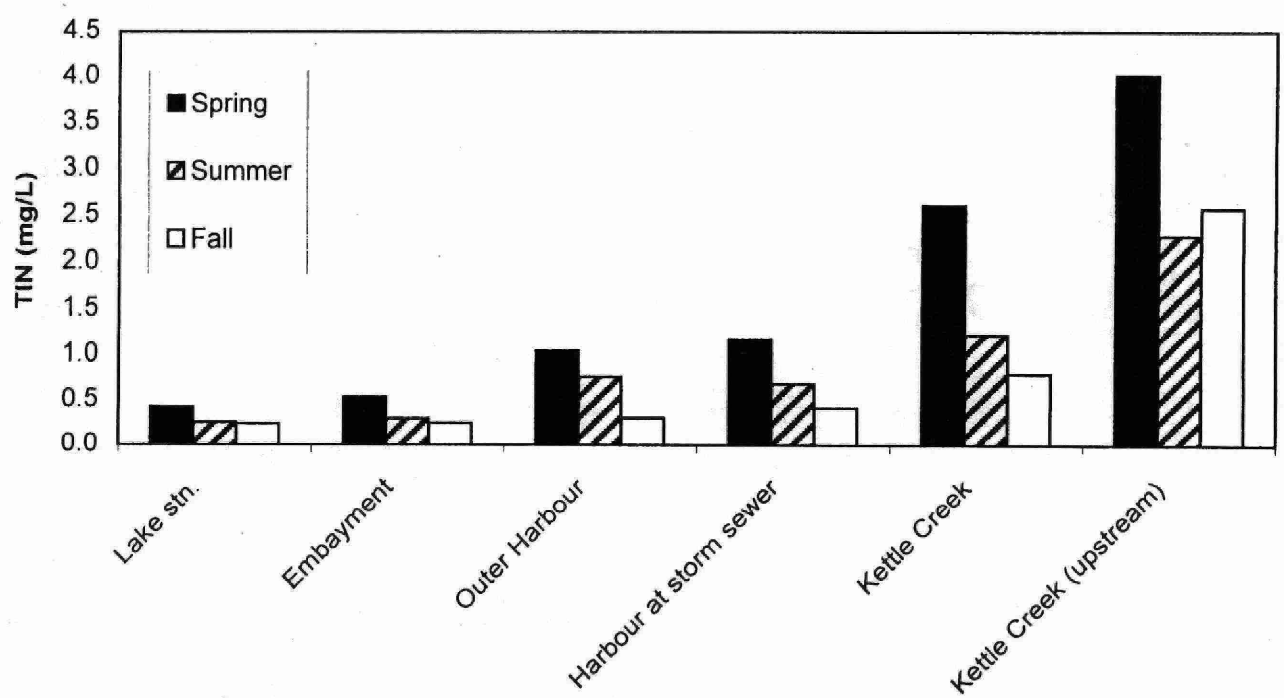


Table 14: Concentrations of nutrients, conventional parameters, metals and p'p-DDE in sediment collected from Port Stanley, 1998

Station Description	Station Number		Date YYYYMMDD	Sample Depth (m)	Aluminum ug/g	Arsenic ug/g	Cadmium ug/g	RMK	Chromium ug/g	Copper ug/g	Iron ug/g	Mercury ug/g	RMK
Port Stanley-lake stn.	1	1356	19980811	10.8	10000	15.0	0.5	<T	15	16	21000	0.03	<T
Port Stanley-embayment	1	1355	19980811	2.0	4100	1.6	0.2	<=W	7	6	8100	0.02	<T
	1	1355	19980811	2.0	3900	1.7	0.3	<T	8	7	8000	0.02	<T
	1	1355	19980811	2.0	4100	1.6	0.2	<=W	7	8	8300	0.01	<=W
Port Stanley-Harbour	17	58	19980811	7.1	10000	3.1	0.4	<T	15	18	15000	0.02	<T
	17	58	19980811	7.1	7900	2.6	0.3	<T	12	14	13000	0.02	<T
	17	58	19980811	7.0	11000	3.1	0.5	<T	16	18	15000	0.02	<T
Port Stanley-Harbour at storm sewer	17	57	19980811	2.1	7300	2.5	0.3	<T	11	11	12000	0.02	<T
	17	57	19980811	2.1	8200	2.4	0.3	<T	12	12	13000	0.02	<T
	17	57	19980811	2.1	8200	2.6	0.2	<=W	13	13	13000	0.03	<T
Port Stanley-Kettle Creek	15	67	19980811	6.1	18000	3.8	0.5	<T	25	24	22000	0.04	<T
	15	67	19980811	6.1	19000	3.9	0.7	<T	26	26	23000	0.04	<T
split	15	67	19980811	6.1	19000	3.9	0.7	<T	25	24	22000	0.04	<T
split	15	67	19980811	6.1	19000	3.7	0.5	<T	25	23	22000	0.04	<T
Port Stanley-Kettle Creek (upstream)	15	66	19980811	2.5	24000	4.6	0.8	<T	31	30	27000	0.05	
	15	66	19980811	2.5	15000	3.4	0.2	<=W	22	23	21000	0.03	<T
	15	66	19980811	2.5	22000	4.2	0.8	<T	30	29	26000	0.03	<T
Lowest Effect Level (ug/g)						6	0.6		26	16	20000	0.2	
Severe Effect Level (ug/g) **						33	10		110	110	40000	2	
Background - Great Lakes pre-colonial sediment horizon, Persaud et al. (1992)						4.2	1.1		31	25	31000	0.1	
Background - Lake Erie pre-colonial sediment horizon for Harbours (H) and/or depositional zones (D), Mudroch et al. (1988)						0.5-1.2 (H)	0.1 (H) 0.1-1.7(D)		30-250(H) 9-25(D)	10-110(H) 20-48(D)	1000- 15000(H) 8900-48200(D)	0.05-7(H)	

Station Description	Station Number		Manganese ug/g	Nickel ug/g	Lead ug/g	RMK	Zinc ug/g	RMK	TKN mg/g	RMK	Total Phosphorus mg/g	Loss on Ignition (mg/g)	RMK	TOC (mg/g)	RMK	Clay %	Silt %	Sand %	RMK
Port Stanley-lake stn.	1	1356	630	16	6	<T	40		0.1	<=W	0.5	13		5		20	31	15	
Port Stanley-embayment	1	1355	350	5	2	<=W	22	<T	0.1	<=W	0.4	2.4	<T	1	<=W	4	29	67	
	1	1355	340	5	3	<T	29		0.1	<=W	0.6	3		1	<=W	5	31	64	
	1	1355	350	5	2	<=W	24	<T	0.1	<=W	0.5	5.3		23		6	37	57	
Port Stanley-Harbour	17	58	500	12	4	<T	44		0.1	<=W	0.6	16		20		19	71	9	
	17	58	480	11	6	<T	40		0.1	<=W	0.6	12		11		15	70	15	
	17	58	620	13	7	<T	46		0.2	<T	0.6	16		17		19	65	16	
Port Stanley-Harbour at storm sewer	17	57	440	10	6	<T	34		0.1	<=W	0.6	13		4	<T	14	57	28	
	17	57	450	10	6	<T	37		0.1	<=W	0.6	14		8		18	62	20	
	17	57	460	10	4	<T	40		0.1	<=W	0.6	15		10		17	64	19	
Port Stanley-Kettle Creek	15	67	650	20	14		74		0.7		0.9	33		12		32	60	7	
	15	67	590	21	12		77		1.0		0.9	33		17		34	63	3	<T
split	15	67	570	20	13		73		0.8		0.8	32		16		32	62	7	
split	15	67	540	19	12		71		0.8		0.8	33		14		32	62	5	
Port Stanley-Kettle Creek (upstream)	15	66	690	24	17		95		1.2		1.0	39		13		41	59	1	<=W
	15	66	650	18	10		72		0.8		0.8	33		19		35	60	5	
	15	66	660	22	14		88		1.0		0.9	40		17		36	60	3	<T
Lowest Effect Level (ug/g)			460	16	31		120		0.55 mg/g		0.6 mg/g			10 mg/g					
Severe Effect Level (ug/g) **			1100	75	250		820		4.8 mg/g		2.0 mg/g			100 mg/g					
Background - Great Lakes pre-colonial sediment horizon, Persaud et al. (1992)			400	31	23		65												
Background - Lake Erie pre-colonial sediment horizon for Harbours (H) and/or depositional zones (D), Mudroch et al. (1988)				55-65(H) 10-76(D)	21-49(D)		40-500(H) 8-128(D)												

<W no measurable response
<T measurable trace amount, interpret with caution
<=> approximate value

Station Description	Station Number		p'p-DDE ng/g	RMK
Port Stanley-Kettle Creek	15	67	3	<T
	15	67	4	<T
split	15	67	3	<T
split	15	67	3	<T
Port Stanley-Kettle Creek (upstream)	15	66	5	<T
	15	66	4	<T
	15	66	4	<T
Lowest Effect Level (ng/g)			5	

Table 15: Concentrations of polycyclic aromatic hydrocarbons (ng/g) in sediment collected from Port Stanley, 1998

Station Description	Station Number	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b) fluoranthene	Benzo(k) fluoranthene	Chrysene	Dibenzo(ah) anthracene
Port Stanley-lake stn.	1 1356	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Port Stanley-embayment	1 1355	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	1 1355	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	1 1355	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Port Stanley-Harbour	17 58	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	20 <=W	20 <=W	40 <=W
	17 58	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	17 58	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Port Stanley-Harbour at storm sewer	17 57	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	17 57	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	17 57	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	40 <T	40 <=W
Port Stanley-Kettle Creek	15 67	20 <=W	20 <=W	20 <=W	40 <T	80 <T	60 <T	60 <T	60 <T	40 <=W
	15 67	20 <=W	20 <=W	20 <=W	40 <T	40 <=W	80 <T	60 <T	60 <T	40 <=W
split	15 67	20 <=W	20 <=W	20 <=W	40 <T	40 <=W	60 <T	40 <T	60 <T	40 <=W
split	15 67	40 <T	20 <=W	20 <=W	20 <=W	40 <=W	60 <T	40 <T	60 <T	40 <=W
Port Stanley-Kettle Creek (upstream)	15 66	40 <T	20 <=W	20 <=W	40 <T	80 <T	80 <T	60 <T	80 <T	40 <=W
	15 66	20 <=W	20 <=W	20 <=W	40 <T	80 <T	60 <T	60 <T	60 <T	40 <=W
	15 66	40 <T	20 <=W	20 <=W	40 <T	80 <T	80 <T	60 <T	80 <T	40 <=W
Lowest Effect Level (ng/g)				220	320	370		240	340	60

Station Description	Station Number	Fluoranthene	Fluorene	Benzo(g,h,I) perylene	Indeno(1,2,3-cd) pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH
Port Stanley-lake stn.	1 1356	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Port Stanley-embayment	1 1355	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	1 1355	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	1 1355	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Port Stanley-Harbour	17 58	40 <T	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	80
	17 58	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
	17 58	40 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	40 <T	120
Port Stanley-Harbour at storm sewer	17 57	40 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	40 <T	120
	17 57	40 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	40 <T	120
	17 57	60 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	40 <T	180
Port Stanley-Kettle Creek	15 67	120	20 <=W	80 <T	40 <=W	20 <=W	60 <T	100	660
	15 67	140	20 <=W	80 <T	40 <=W	40 <T	80 <T	120	700
split	15 67	120	40 <T	40 <=W	40 <=W	80 <T	100	120	660
split	15 67	100	80 <T	40 <=W	40 <=W	120	120	100	720
Port Stanley-Kettle Creek (upstream)	15 66	160	60 <T	80 <T	40 <=W	160	140	180	1160
	15 66	140	40 <T	80 <T	40 <=W	100	100	140	900
	15 66	160	80 <T	80 <T	80 <T	120	160	160	1220
Lowest Effect Level (ng/g)		750	190	170	200		560	490	4000
						Severe Effect Level (ng/g organic carbon)			10,000

<W no measurable response
<T measurable trace amount, interpret with caution

THAMES RIVER

The Thames River flows through several large urban areas which include Stratford, Ingersol, Woodstock, London, and Chatham before it flows into Lake St. Clair (Figure 22). These urban areas discharge effluent to the river from their respective WPCPs which typically have tertiary treatment. The river also flows through agricultural areas where both livestock and cash crop farming is common.

One station was located at the mouth of the river and one station was located further upstream. There were three stations in Lake St. Clair; one station was located about 1.25 km from the mouth of the Thames River and two stations were located to the east and west of the river mouth. The mean daily discharge for the Thames River ranged from 7 to 486 m^3/sec measured at the Thamesville gauging station (ID 02GE003) (Appendix A). Flow measurements at the time of sampling were 49.0 m^3/sec on April 23, 1998, 7.1 m^3/sec on August 5th and 9.5 m^3/sec on October 14th. Flows were fairly stable for several weeks prior to sampling in August and October but were variable and higher in April prior to the sampling event

All water and sediment data are provided in Tables 16 to 18 and Figures 23 and 24 following the description and interpretation of the data for the Thames River.

Water Quality

Water temperature was consistent at all stations for each season sampled. Water temperature ranged from 12.4 to 16.3 °C in the spring, 23.2 to 24.4 °C in the summer and 12.3 to 15.8 °C in the fall. Dissolved oxygen was also consistent between sampling sites with the lowest concentration in summer at the upper Thames River site (range: summer 5.7 to 8.7 mg/L; fall 7.4 to 10 mg/L). Data were not available for the spring due to equipment failure. The deepest Secchi disc depth readings were present at station 1-232 in Lake St. Clair (range: 0.5 to 1.2 m). However, water clarity was poor in general at all stations due to high suspended solid loadings.

Suspended Solids

In general, suspended solids were high in all water samples. The Thames River mouth station (15-16) and upstream station (15-15) had the highest concentrations suggesting sources within the river (spring: 66.0 to 76.5 mg/L; Summer 22.0 to 27.0 mg/L; fall: 29.0 to 30.0 mg/L). High suspended solids in the spring may have been related to the high spring flow.

The plume from the river appeared to have been moving towards the west in the spring and summer (Figure 23). Suspended solid concentrations were 43.0 and 29.0 mg/L respectively in the spring and summer at station 1-231 located to the west of the river mouth compared with 15.0 mg/L and 8.0 mg/L in water collected from the station to the north of the river mouth (station 1-230) and 14.0 mg/L and 7.0 mg/L at station 1-232 (north-west) of the mouth. The Cl and conductivity data support this theory.

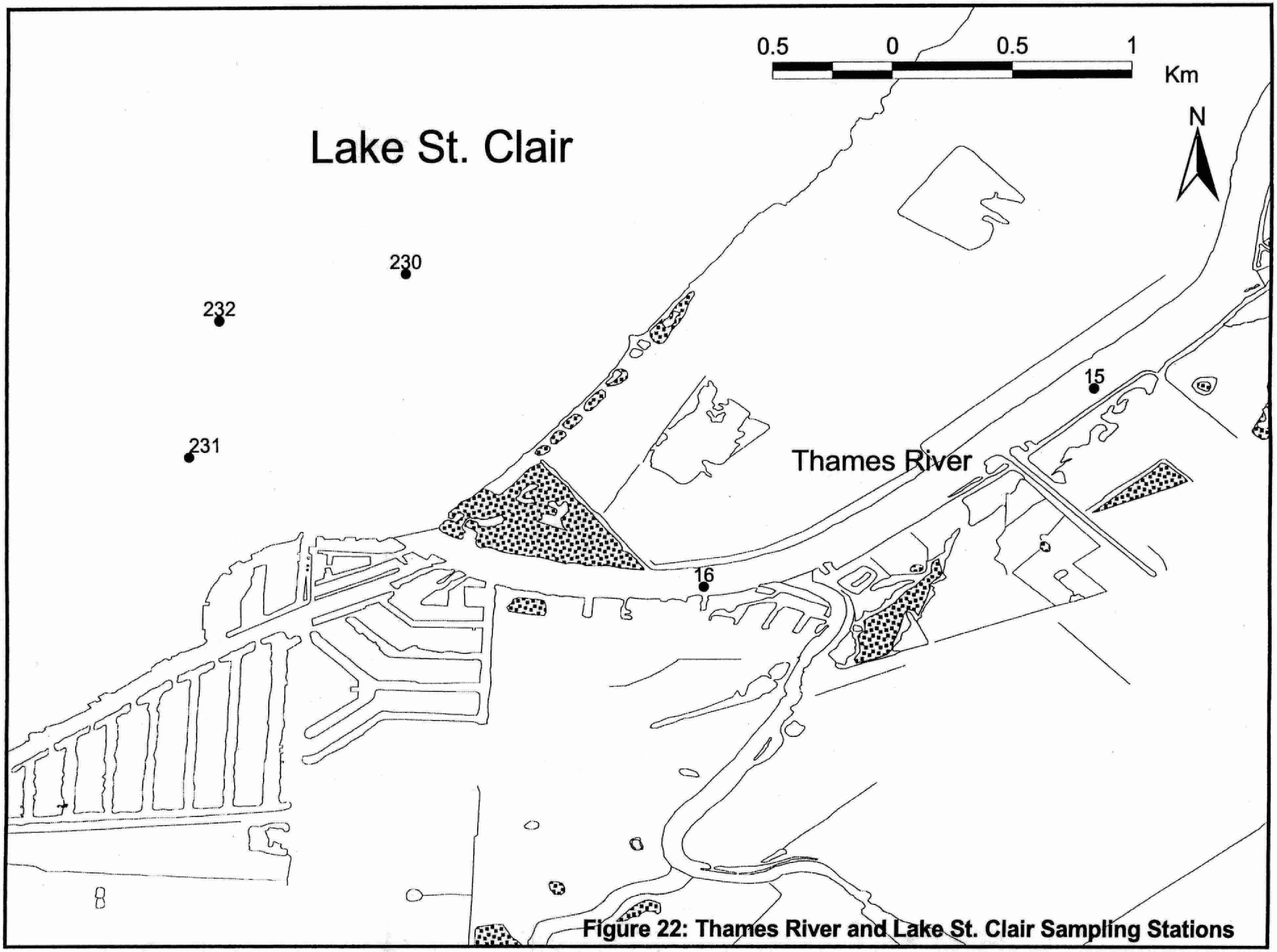


Figure 22: Thames River and Lake St. Clair Sampling Stations

During the fall collection suspended solid concentrations were high at all stations without a clear gradient extending from the Thames River. In fact concentrations at station 1-232 and the station located to the north of the river mouth were greater than the concentrations in water collected from the river mouth and upstream.

Bacteriological Analysis

Bacterial counts were consistently low at all sampling stations and for each survey.

Total Phosphorus

Total phosphorus concentrations were high in water samples collected from the Thames River in each survey, exceeding the PWQO and indicating nutrient enriched conditions (Table 16). In the spring the water sample collected from the upstream station (15-15) had a TP concentrations of 42 *u*g/L while the split sample collected from the mouth of the river (station 15-16) had results that were inconsistent; TP concentrations were 50 and 116 *u*g/L. The TKN concentrations for the split samples were also inconsistent (540 and 1300 *u*g/L), making this data unreliable, although all other parameters including conductivity and suspended solids had minimal discrepancies making the variability difficult to explain.

Concentrations of TP in the summer from the upstream Thames River station and at the mouth of the river were 66 and 74 *u*g/L respectively and in the fall they were 84 and 90 *u*g/L TP.

TP concentrations at the Lake St. Clair stations were lower than the concentrations in the Thames River but still exceeded the PWQO at times suggesting an impact on Lake St. Clair nearshore water quality from the Thames River (Figure 24).

Nitrogen

TIN concentrations were high in the Thames River during all three surveys (range: 0.81 mg/L to 5.07 mg/L), with the highest concentrations present in water samples collected in the spring (Figure 24). Nitrate concentrations were particularly high as were concentrations of TKN (TKN range - Thames River: 0.52 to 1.30 mg/L). Concentrations of TIN at the three Lake St. Clair stations ranged from 1.34 to 4.05 mg/L in the spring and were higher than concentrations in the summer and fall.

Concentrations of TIN were up to ten times higher than concentrations of TON in the spring in the Thames River which suggests nitrogen inputs due to runoff from land based practices likely related to agriculture. In the summer the ratio of inorganic nitrogen to organic nitrogen was equal to one at most stations and less than one at two of the stations in Lake St. Clair. In the fall concentrations of inorganic nitrogen were twice as high as organic nitrogen in the Thames River while organic nitrogen was higher than inorganic nitrogen in Lake St. Clair.

Chloride

Chloride and conductivity measurements followed a similar pattern to suspended solids (Figure 23). High concentrations of Cl (and conductivity readings), were present in the Thames River and at the station to the west of the river mouth in the spring (range: 36 to 40 mg/L) and summer (range: 27 to 59 mg/L), compared with station 1-232 and the station to the north of the river which had concentrations that were less than 15 mg/L during those two sampling events. The highest Cl concentrations in the Thames River were present in the fall samples (up to 80 mg/L) while the highest concentrations in Lake St. Clair were present in the spring samples.

Conductivity readings in the Thames River were high and ranged from 477 to 697 *u*homs/cm over the three surveys.

Trace Metals

All trace metal concentrations were below the PWQO with the exception of Al, Fe and Cr. High concentrations of suspended solids in water samples likely influenced the concentrations of the metals. Chromium concentrations were present at trace levels and should be interpreted with caution.

In the spring, Al was greater than the PWQO at all stations sampled and Fe exceeded the provincial objective at all stations except station 1-232 and the station north of the river. Aluminum concentrations were greater than the PWQO in water collected from the Thames River in the summer and Al, Fe and Cr concentrations were greater than the PWQO in water collected from all stations with the exception of the station to the west of the mouth of the river in the fall.

<u>Sediment Quality</u>

Sediment Physical Qualities

Sediment samples collected from Lake St. Clair were greater than 90% sand. This greatly influenced sediment contaminant concentrations. TOC and LOI were low at all three stations (TOC range - below the detection limit to 11 mg/g; LOI - 4.2 to 14 mg/g). The station at the mouth of the Thames River had sediment that was high in percent silt and clay (98%), while the samples collected at the station further upstream in the Thames River had a 60% silt content and an equal proportion of clay and sand. TOC and LOI were higher at these two sites than at the Lake St. Clair stations (range:16 to 21 mg/g and 32 to 51 mg/g respectively).

Metals and Nutrients

All metal and nutrient concentrations were below the LEL at the three stations in Lake St. Clair due to the high sand content in those samples (Table 17). Sediment contaminant concentrations were higher in samples collected from the mouth of the river than in the samples collected further upstream. However, contaminant concentrations at these two stations were low in general and remained below the LEL or slightly exceeded the LEL. The LEL was exceeded at the mouth of the Thames for Cr, Mn, Ni, Cu, Zn, Cd, As, TKN, TP and TOC while at the upstream station the LEL was exceeded for only Ni, Cu, Cd, TOC, TKN and TP. Sediment samples collected from the mouth of the river also exceeded the Great Lakes and/or Lake Erie background concentrations for As, Zn and Fe.

The ratio of contaminant concentrations to Al was calculated for parameters with detectable concentrations to determine if there were any patterns of enrichment. Only phosphorus appeared enriched at the Lake St. Clair stations.

Organochlorine Pesticides and Chlorinated Benzenes

Organochlorine pesticides and chlorinated benzenes were not detected in any sediment samples with the exception of trace concentrations of p'p-DDT at the three stations in Lake St. Clair and in one sample collected from the upstream station in the Thames River (station 15-15) (p'p-DDT 5 ng/g). This station had one replicate sample with trace concentrations of β-BHC (4 ng/g), γ-chlordane (12 ng/g) and detectable concentrations of oxychlordane (40 ng/g).

Polycyclic Aromatic Hydrocarbons (PAHs)

Trace concentrations of phenanthrene, pyrene and fluoranthene were present in sediment collected from station 01-230 (north of the Thames River) and at the mouth of the Thames River (station 15-16).

The replicate sample collected from station 15-15 upstream in the Thames River that had detectable concentrations of organochlorine pesticides also had PAHs at concentrations that were inconsistent with the other two replicate samples (Table 18). Concentrations of individual PAH compounds ranged from 120 to 2700 ng/g in one replicate sediment sample compared with a range from 40 to 220 ng/g in the other two replicates.

Table 16: Concentration of nutrients, conventional parameters and bacteria in water collected from Lake St. Clair and the Thames River, 1998

Station Description	Station number			Date YYYYMMDD	Water Depth (m.)	Sample Depth (m.)	Secchi Depth (m)	Water Temp. °C	DO (field) mg/L as O	Conductivity (field) uS/cm 25 C	pH	pH (Field)	*E. coli* count/100mL	RMK	Fecal Streptococci count/100mL	RMK	*Pseudomonas aeruginosa* count/100mL	RMK	Chloride mg/L	RMK	Ammonia/ ammonium mg/L	RMK	Nitrite mg/L	RMK	Nitrite/Nitrate mg/L	RMK	Total Inorganic Nitrogen	TKN mg/L	RMK	Total Organic Nitrogen	Total Phosphorus mg/L	RMK	Suspended Solids mg/L	RMK
Spring																																		
Lake St. Clair-Thames River	4	1	232	19980423	2.5	1.5	0.6	12.4	-	346		8.73	4	<	4	<	2	<	14.8		0.016		0.012		1.340		1.356	0.44		0.42	0.034		14.0	
Lake St. Clair-West of Thames River	4	1	231	19980423	1.3	0.5	0.2	14.7	-	512		8.83	10	<	10	<	4	<	36.4		0.028		0.031		4.050		4.078	1.24		1.21	0.100		43.0	
Lake St. Clair-North of Thames River	4	1	230	19980423	2.0	1.0	0.6	12.9	-	288		8.65	4	<	4	<	2	<	14.2		0.018		0.012		1.370		1.388	0.42		0.40	0.030		15.0	
Thames River-mouth	4	15	16	19980423	5.4	1.5	0.3	12.7	-	585		8.69	10	<	10	<=>	4	<	39.6		0.032		0.045		4.760		4.792	1.30		1.27	0.116		67.0	
Split	4	15	16	19980423	5.2	1.5	0.3	12.9	-	587		8.68	10	<	10	<	4	<	39.6		0.032		0.044		4.870		4.902	0.54		0.51	0.050		66.0	
Thames River (upstream)	4	15	15	19980423	1.3	0.5	0.3	16.3	-	573		8.71	10	<	10	<=>	4	<	38.8		0.026		0.045		5.040		5.066	0.52		0.49	0.042		76.5	
Summer																																		
Lake St. Clair-Thames River	4	1	232	19980805		2.2	1.2	23.2	8.4	207		8.82	4	<	12		2	<	8		0.002	<=W	0.006		0.095		0.097	0.3		0.30	0.014		7	
Lake St. Clair-West of Thames River	4	1	231	19980805		0.5	0.6	23.4	8.7	320	8.42	8.55	7		4	<	2	<	27		0.01		0.035		0.475		0.485	0.48		0.47	0.04		29	
Lake St. Clair-North of Thames River	4	1	230	19980805		0.9	1.5	23.3	8.6	206		8.89	4	<	4		2	<	8		0.002	<=W	0.003	<T	0.09		0.092	0.32		0.32	0.02		8	
Thames River-mouth	4	15	16	19980805		1.5	0.4	24.3	6.4	477		7.93	10		10		2	<	55.2		0.14		0.067		0.68		0.820	0.84		0.70	0.074		27.5	
Split	4	15	16	19980805		1.5	0.4	24.3	6.4	477		7.94	4		4	<	2	<	54.6		0.136		0.069		0.675		0.811	0.82		0.68	0.072		26	
Thames River (upstream)	4	15	15	19980805		0.5	0.4	24.4	5.7	499		7.82	4		7		2	<	59.2		0.156		0.077		0.71		0.866	0.82		0.66	0.066		22.5	
Fall																																		
Lake St. Clair-Thames River	4	1	232	19981014	2.1	1.0	0.5	14.0	9.8	216		8.06	10	<	10	<	2	<	7.4		0.002	<=W	0.002	<T	0.205		0.207	0.50		0.50	0.050		48.5	
Lake St. Clair-West of Thames River	4	1	231	19981014	1.5	0.5	0.8	12.9	10.0	213		8.07	10	<	10	<	2	<	6.8		0.002	<=W	0.002	<T	0.185		0.187	0.26		0.26	0.024		19.0	
Lake St. Clair-North of Thames River	4	1	230	19981014	1.2	0.5	0.4	12.3	10.0	356		8.10	10	<=>	10	<=>	2	<	28.8		0.022		0.010		0.335		0.357	0.60		0.58	0.084		49.0	
Thames River-mouth	4	15	16	19981014	4.0	1.5	0.2	15.8	7.4	691		7.75	30	<=>	20	<=>	2	<	78.8		0.246		0.055		1.660		1.906	1.04		0.79	0.090		30.0	
Split	4	15	16	19981014	4.0	1.5	0.2	15.7	7.4	692		7.75	10	<	70	<=>	2	<	79.6		0.248		0.057		1.660		1.908	1.04		0.79	0.090		29.5	
Thames River (upstream)	4	15	15	19981014	1.0	0.5	0.2	15.7	8.1	697		7.86	10	<=>	20	<=>	2	<	79.8		0.226		0.054		1.730		1.956	1.04		0.81	0.084		29.0	
Thames River (F-blank)	4	15	15	19980423															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.02	<=W	0.02	0.008	<T	1.0	<T
Thames River (T-blank)	4	15	15	19980423															0.2	<=W	0.002	<=W	0.001	<=W	0.005	<=W	0.007	0.02	<=W	0.02	0.004	<T	1.0	<T
Thames River (F-blank)	4	15	15	19981014															0.2	<=W	0.004	<T	0.001	<=W	0.010	<T	0.014	0.02	<=W	0.02	0.002	<=W	1.0	<T
Thames River (T-blank)	4	15	15	19981013															0.2	<=W	0.010		0.001	<=W	0.005	<=W	0.015	0.02	<=W	0.01	0.002	<=W	1.0	<T

<W no measurable response
<T measurable trace amount, interpret with caution
<=> approximate value
F-blank field blank
T-blank travel blank

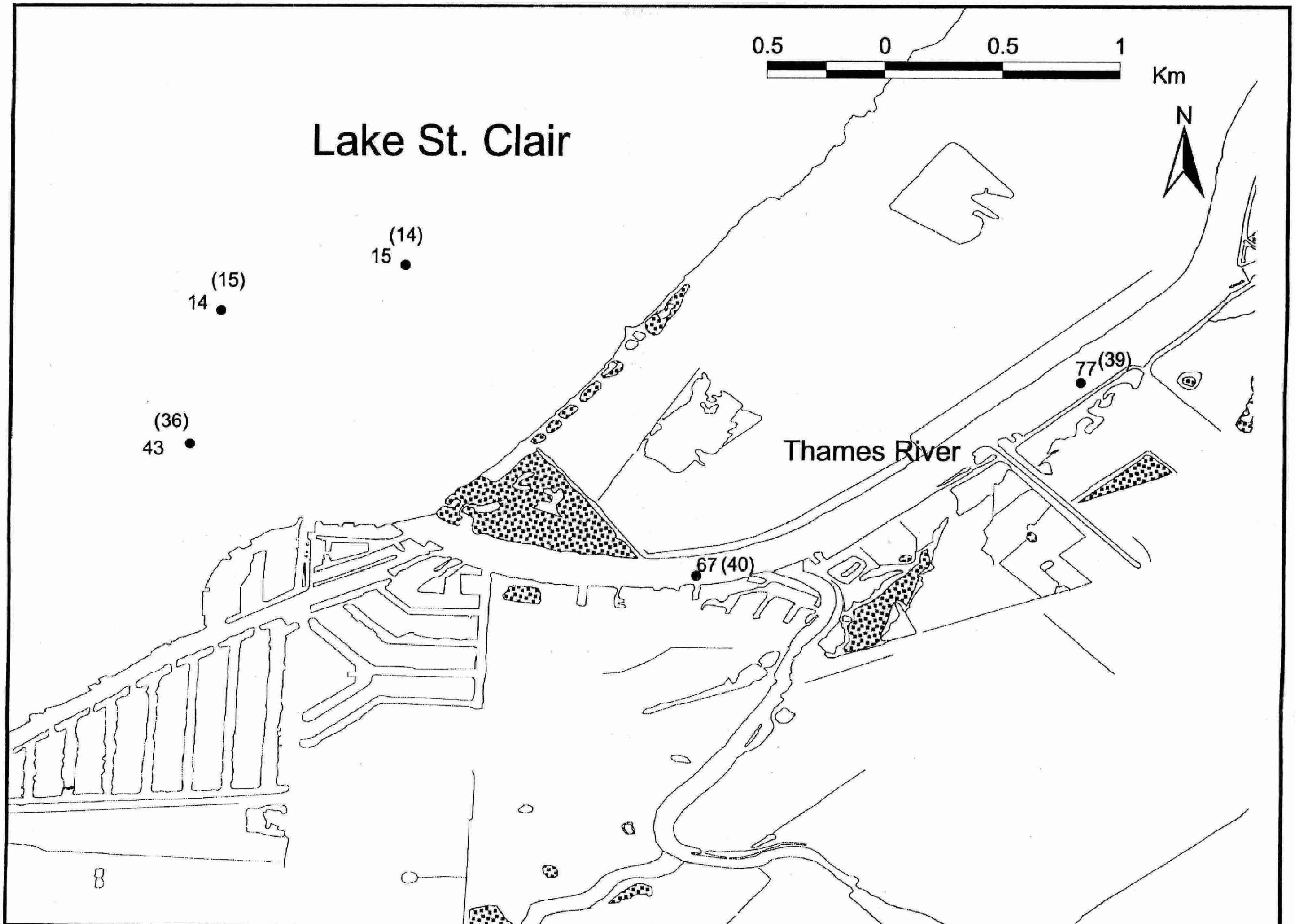


Figure 23: Spring Suspended Solids Concentration and (Chloride Concentrations) (mg/L), Thames River and Lake St. Clair, 1998

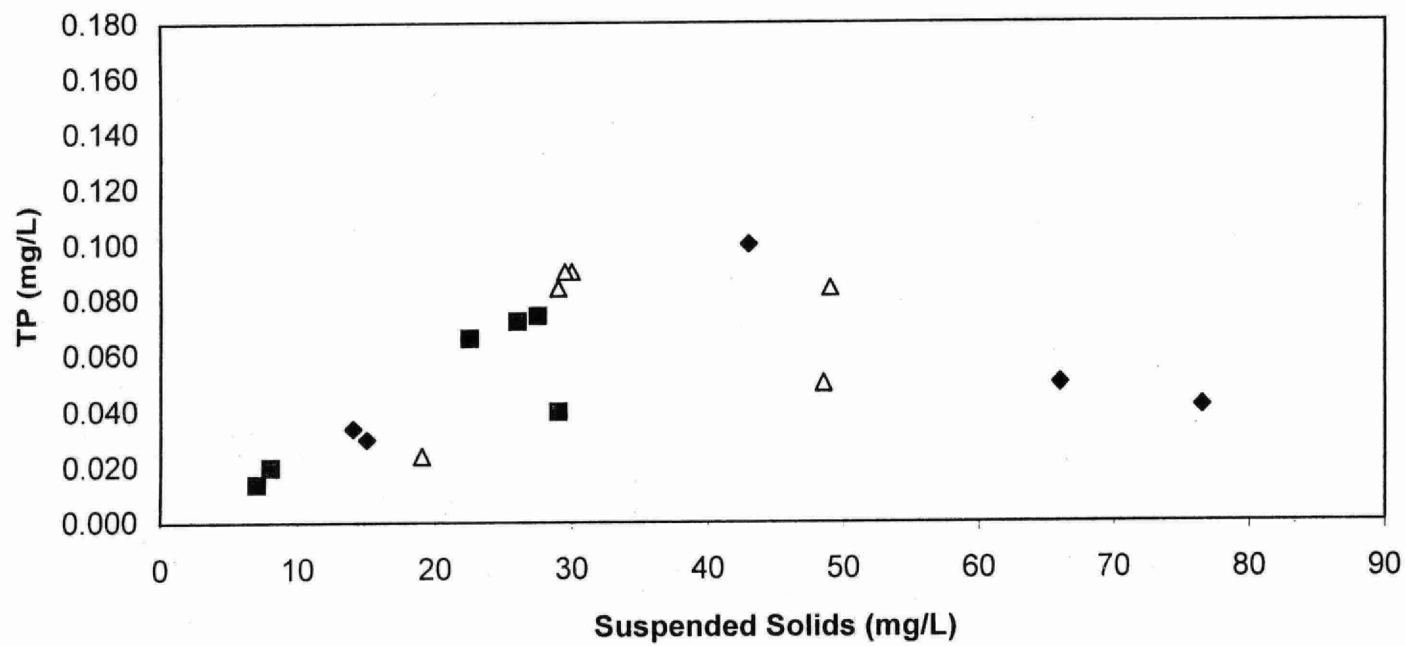
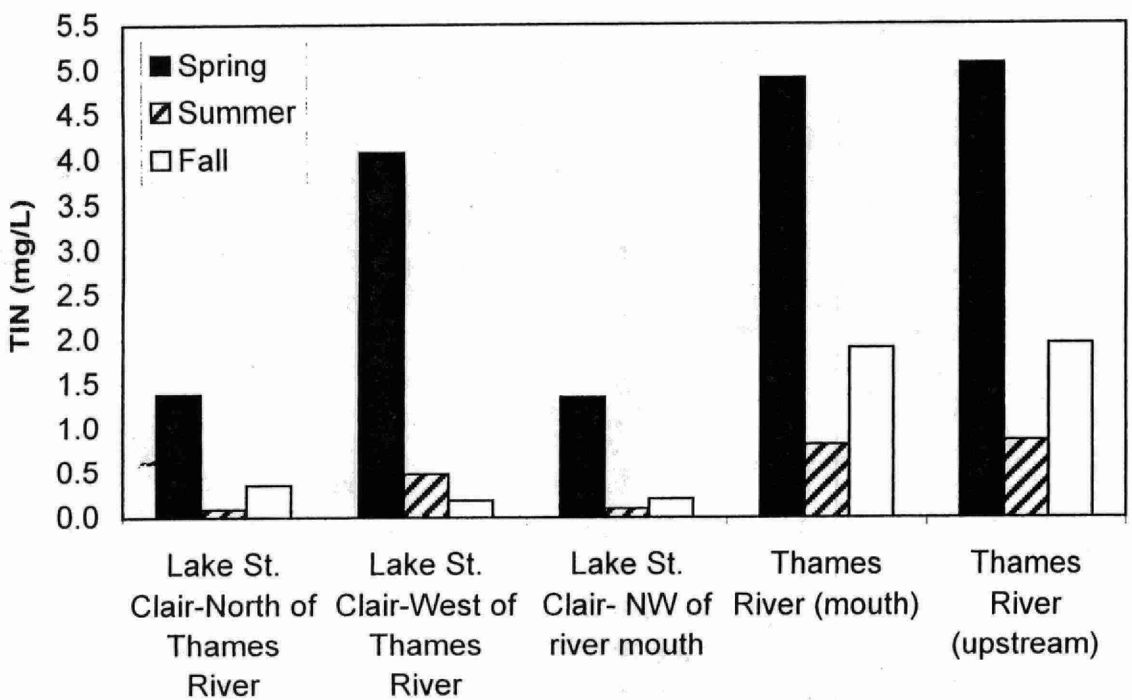


Figure 24: Water quality parameters in Surface grab samples - Lake St. Clair and Thames River, 1998



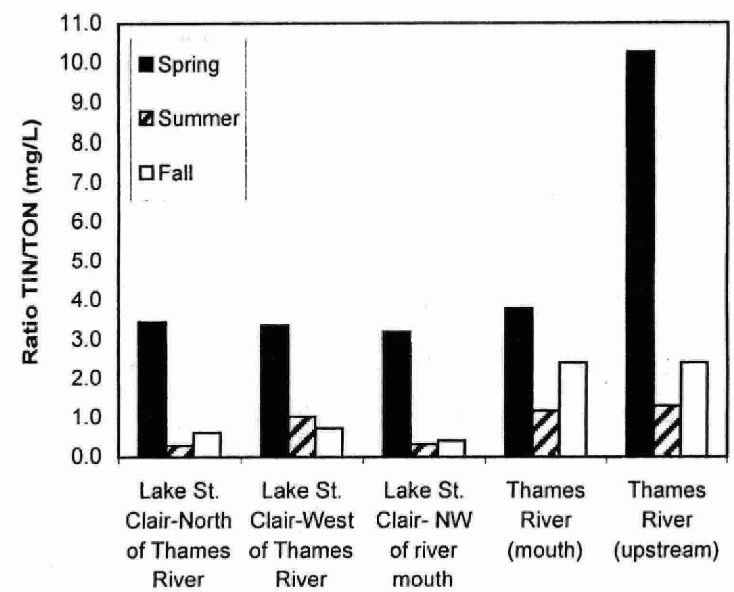


Table 17: Concentrations of nutrients, conventional parameters and metals in sediment collected from Lake St. Clair and the Thames River, 1998

Station Description	Station Number			Date YYYYMMDD	Sample Depth (m)	Aluminum ug/g	Arsenic ug/g	Cadmium ug/g	RMK	Chromium ug/g	Copper ug/g	RMK	Iron ug/g
Lake St. Clair-West of Thames River	4	1	231	19980805	1.2	2100	1.6	0.2	<=W	7	1	<=W	6100
Lake St. Clair-West of Thames River	4	1	231	19980805	1.2	2200	1.6	0.2	<=W	7	1	<=W	5600
Lake St. Clair-West of Thames River	4	1	231	19980805	1.2	2400	1.5	0.3	<T	8	2	<T	6500
Lake St. Clair-Thames River	4	1	232	19980804	2.2	2800	1.4	0.2	<=W	8	2	<T	7200
Lake St. Clair-Thames River	4	1	232	19980804	2.2	2500	1.6	0.3	<T	10	2	<T	7600
Lake St. Clair-Thames River	4	1	232	19980804	2.2	2700	1.6	0.3	<T	21	2	<T	7400
Lake St. Clair-Thames River	4	1	232	19980805	2.2	2500	1.6	0.3	<T	10	2	<T	7200
Lake St. Clair-North of Thames River	4	1	230	19980805	1.9	3500	2.3	0.2	<=W	8	3	<T	6400
Lake St. Clair-North of Thames River	4	1	230	19980805	1.9	3300	2.2	0.3	<T	8	3	<T	6300
Lake St. Clair-North of Thames River	4	1	230	19980805	1.9	3200	2.1	0.3	<T	8	2	<T	6000
Thames River-mouth	4	15	16	19980805	5.7	28000	7.4	1.2		37	29		30000
Thames River-mouth	4	15	16	19980805	5.7	28000	7.3	0.6	<T	37	30		30000
Thames River-mouth	4	15	16	19980805	5.7	26000	7.3	1.1		35	30		30000
Thames River (upstream)	4	15	15	19980805	0.9	12000	3.9	0.8	<T	18	21		16000
Thames River (upstream)	4	15	15	19980805	0.9	11000	3.8	0.5	<T	17	19		15000
Thames River (upstream)	4	15	15	19980805	0.9	12000	3.9	0.8	<T	18	19		15000
Lowest Effect Level (*ug/g*)							**6**	**0.6**		**26**	**16**		**20000**
Severe Effect Level (*ug/g*) **							**33**	**10**		**110**	**110**		**40000**
Background - Great Lakes pre-colonial sediment horizon, Persaud et al. (1992)							**4.2**	**1.1**		**31**	**25**		**31000**
Background - Lake Erie pre-colonial sediment horizon for Harbours (H) and/or depositional zones (D), Mudroch et al. (1988)							**0.5-1.2 (H)**	**0.1 (H) 0.1-1.7(D)**		**30-250(H) 9-25(D)**	**10-110(H) 20-48(D)**		**1000-15000(H) 8900-48200(D)**

Station Description	Mercury ug/g	RMK	Manganese ug/g	Nickel ug/g	Lead ug/g	RMK	Zinc ug/g	RMK	TKN mg/g	RMK	Total Phosphorus mg/g	Loss on Ignition (mg/g)	TOC (mg/g)	RMK	Clay %	RMK	Silt %	RMK	Sand %	RMK
Lake St. Clair-West of Thames River	0.01	<=W	150	4	3	<T	15	<T	0.1	<=W	0.2	6	2	<T	0		2	<T	98	
Lake St. Clair-West of Thames River	0.01	<=W	150	4	2	<=W	15	<T	0.1	<=W	0.2	5	1	<=W	0		2	<T	98	
Lake St. Clair-West of Thames River	0.01	<=W	160	4	3	<T	21	<T	0.1	<=W	0.2	6	1	<=W	0		1	<=W	98	
Lake St. Clair-Thames River	0.01	<=W	190	4	4	<T	23	<T	0.1	<=W	0.5	8	2	<T	1		3	<T	96	
Lake St. Clair-Thames River	0.01	<=W	190	5	4	<T	23	<T	0.1	<=W	0.4	6	2	<T	1	<T	3	<T	92	
Lake St. Clair-Thames River	0.01	<=W	180	9	5	<T	21	<T	0.1	<=W	0.5	6	1	<=W	1	<T	2	<T	91	
Lake St. Clair-Thames River	0.01	<=W	180	5	5	<T	28	<T	0.1	<=W	0.3	4	1	<=W	1	<T	2	<T	94	
Lake St. Clair-North of Thames River	0.02	<T	250	6	6	<T	19	<T	0.1	<=W	0.3	14	4	<T	1	<T	4	<T	95	
Lake St. Clair-North of Thames River	0.02	<T	260	5	2	<=W	16	<T	0.1	<=W	0.2	10	2	<T	1	<T	3	<T	97	
Lake St. Clair-North of Thames River	0.02	<T	250	6	7	<T	18	<T	0.1	<=W	0.3	10	11		1	<T	2	<T	97	
Thames River-mouth	0.03	<T	580	33	17		110		1.8		1.0	51	21		47		52		1	<=W
Thames River-mouth	0.01	<=W	590	32	15		120		1.6		1.0	51	16		47		53		1	<=W
Thames River-mouth	0.01	<=W	590	33	14		120		1.6		1.0	46	21		46		54		1	<=W
Thames River (upstream)	0.02	<T	410	16	12		57		0.6		0.8	32	19		19		59		22	
Thames River (upstream)	0.03	<T	410	15	11		54		0.7		0.7	34	18		19		61		21	
Thames River (upstream)	0.04	<T	400	16	8	<T	56		0.6		0.7	34	16		19		61		20	
Lowest Effect Level (*ug/g*)	**0.2**		**460**	**16**	**31**		**120**		**0.55 mg/g**		**0.6 mg/g**		**10 mg/g**							
Severe Effect Level (*ug/g*) **	**2**		**1100**	**75**	**250**		**820**		**4.8 mg/g**		**2.0 mg/g**		**100 mg/g**							
Background - Great Lakes pre-colonial sediment horizon, Persaud et al. (1992)	**0.1**		**400**	**31**	**23**		**65**													
Background - Lake Erie pre-colonial sediment horizon for Harbours (H) and/or depositional zones (D), Mudroch et al. (1988)	**0.05-7(H)**			**55-65(H) 10-76(D)**	**21-49(D)**		**40-500(H) 8-128(D)**													

<W no measurable response

<T measurable trace amount, interpret with caution

<=> approximate value

Table 18: Concentrations of polycyclic aromatic hydrocarbons (ng/g) in sediment collected from Lake St. Clair and the Thames River, 1998

Station Description		Station Number	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b) fluoranthene	Benzo(k) fluoranthene	Chrysene	Dibenzo(ah) anthracene
Lake St. Clair-West of Thames R	1	231	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Lake St. Clair-West of Thames R	1	231	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Lake St. Clair-West of Thames R	1	231	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Lake St. Clair-Thames River	1	232	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Lake St. Clair-Thames River	1	232	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Lake St. Clair-Thames River	1	232	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Lake St. Clair-Thames River	1	232	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Lake St. Clair-North of Thames R	1	230	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	40 <T	40 <=W
Lake St. Clair-North of Thames R	1	230	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Lake St. Clair-North of Thames R	1	230	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Thames River-mouth	15	16	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	40 <T	40 <T	40 <=W
Thames River-mouth	15	16	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	40 <T	40 <T	40 <=W
Thames River-mouth	15	16	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	40 <T	40 <T	40 <=W
Thames River (upstream)	15	15	20 <=W	20 <=W	20 <=W	40 <T	40 <=W	60 <T	60 <T	60 <T	40 <=W
Thames River (upstream)	15	15	260	20 <=W	460	740	760	680	680	820	120 <T
Thames River (upstream)	15	15	20 <=W	20 <=W	20 <=W	60 <T	80 <T	80 <T	80 <T	100	40 <=W
Lowest Effect Level (ng/g)					220	320	370		240	340	60

Station Description		Station Number	Fluoranthene	Fluorene	Benzo(g,h,I) perylene	Indeno(1,2,3-cd) pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH
Lake St. Clair-West of Thames R	1	231	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Lake St. Clair-West of Thames R	1	231	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Lake St. Clair-West of Thames R	1	231	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Lake St. Clair-Thames River	1	232	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Lake St. Clair-Thames River	1	232	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Lake St. Clair-Thames River	1	232	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Lake St. Clair-Thames River	1	232	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Lake St. Clair-North of Thames R	1	230	80 <T	20 <=W	40 <=W	40 <=W	20 <=W	60 <T	80 <T	260
Lake St. Clair-North of Thames R	1	230	60 <T	20 <=W	40 <=W	40 <=W	20 <=W	60 <T	60 <T	180
Lake St. Clair-North of Thames R	1	230	40 <T	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	40 <T	80
Thames River-mouth	15	16	80 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	60 <T	300
Thames River-mouth	15	16	80 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	60 <T	300
Thames River-mouth	15	16	80 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	80 <T	320
Thames River (upstream)	15	15	100	20 <=W	80 <T	80 <T	80 <T	40 <T	100	700
Thames River (upstream)	15	15	2700	240	520	600	120	2300	2100	13100
Thames River (upstream)	15	15	220	20 <=W	40 <=W	80 <T	20 <=W	120	180	1000
Lowest Effect Level (ng/g)			750	190	170	200		560	490	4000
							Severe Effect Level (ng/g organic carbon)			10,000

<W no measurable response
<T measurable trace amount, interpret with caution

WHEATLEY

Wheatley Harbour was designated an IJC Area of Concern in part due to PCB contamination in the sediment. A RAP is currently being developed for the harbour. Detailed descriptions of point and non-point sources and environmental conditions are provided in the RAP Stage 1 and 2 Final Report (MOE et al 1990; Zaranko Environmental Assessment Services 1998).

Muddy Creek flows into the north end of the harbour. The creek flows primarily through agricultural land and most of the watershed is surrounded by rural development. Agricultural practices upstream of the harbour contribute high concentrations of nutrients and suspended solids to Muddy Creek. The harbour is a major base for the Canadian commercial fleet, which fishes the western and central basin of Lake Erie. The harbour houses Omstead Foods Limited which is a large fish processing plant, a dockage facility for commercial fishing vessels, the Omstead Food Processing plant, Hikes Metals Ltd., Maclean Brothers Fisheries and a small commercial shipyard. Hikes Metal does not use processing water and is therefore classified as a dry industry. Historically, substances such as metals, lubricants and paint may have entered the harbour via site run-off (Zaranko Environmental Assessment Services 1998). The Maclean Fishery directs its process water to the Wheatley-Romney Township Sewage Treatment Plant. Treated wastewater from the Omstead Foods Ltd. fish processing plant and food processing plant is discharged to Muddy Creek upstream of the harbour. As a result of many upgrades to the treatment system since 1970 the water quality in the creek and harbour has improved. Historically, water quality impairments included low dissolved oxygen concentrations, high BOD_5, total phosphorus and suspended solids concentrations and bacterial contamination. The PCB contamination was likely due to low levels of PCBs in the fish that were processed at the plant (Zaranko Environmental Assessment Services 1998). Natural flushing action of the harbour is slow due to the restricted outlet and low inflow from Muddy Creek which contributes to the water quality problems.

Sediment samples were collected from six stations as part of the Harbour Water Quality Monitoring Survey (Figure 25). One station was located south of Muddy Creek south of the bridge. One station was located in each slip; the north, middle and south slips. A station was located in the middle of the harbour and a final station was east of the harbour entrance.

All sediment data are provided in Tables 19 to 21 and Figures 26 and 27 following the description and interpretation of the data for Wheatley Harbour.

<u>Sediment Quality</u>

Sediment Physical Qualities

Sediment collected east of the entrance to the harbour (01-539) and south of the bridge (south of Muddy Creek 17-90) were high in percent sand while the remaining sites were high in percent silt plus clay with the exception of the mid harbour station (station 17-93) which was

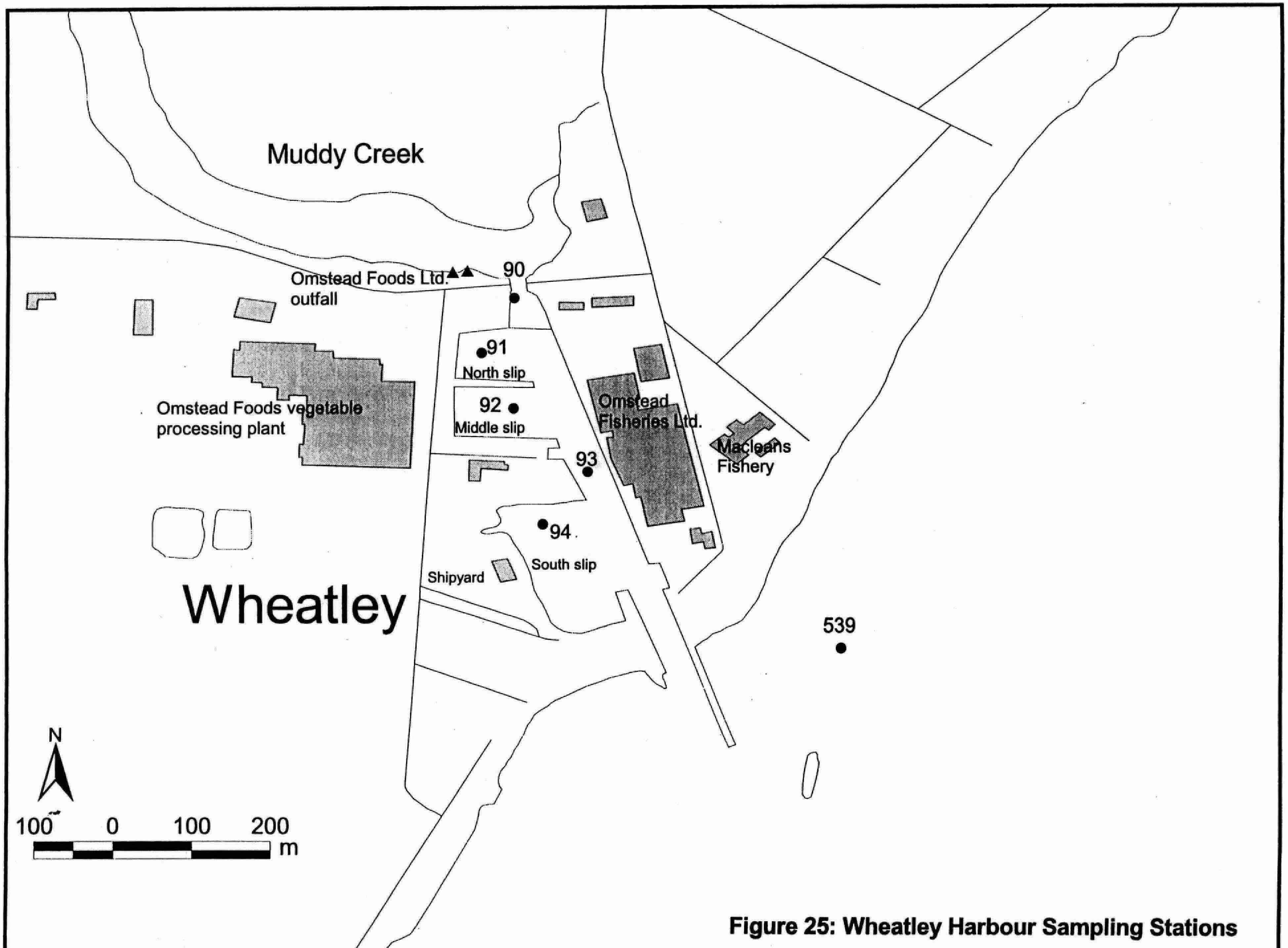


Figure 25: Wheatley Harbour Sampling Stations

characterized as silty sand. TOC (range: 1 (<W- the minimum reportable value) to 27 mg/g), and LOI (range: 12 to 47 mg/g)) concentrations were lowest at the two stations that were high in percent sand. These physical characteristics influenced the contaminant concentrations at these two sites. Concentrations of TOC and LOI were similar at the remaining stations (range - 55 to 75 mg/g and 89 to 150 mg/g respectively). However, the south slip station had lower concentrations of TOC and LOI (29 to 39 mg/g and 62 to 77 mg/g respectively) when compared with the other stations high in percent clay and silt.

Metals and Nutrients

The highest concentrations of most metals (Cd, Cr, Cu, Fe, Hg, Ni, Pb and Zn) and nutrients were present at the north slip (Station 17-91) and middle slip (station 17-92) (Figure 26). Sediment concentrations of metals in the south slip (station 17-94) were similar to concentrations at the mid-harbour site and were lower than the two upstream stations (station 17-91 and 17-92). The lowest concentrations of metals in sediment were at the site south of the bridge (17-90) and east of the harbour entrance (1-539). This was probably due to the high sand content and low TOC concentrations in those samples.

Concentrations of most metals in general (with the exception of Hg and Mn), were greater than the LEL at all sites. The only exceptions were the sites east of the harbour entrance and south of the bridge where concentrations exceeded the LEL for only As and Ni at the former site and Cr and Ni at the latter site. Sediment concentrations of As were similar at all sites suggesting some enrichment at the harbour entrance given the high sand content of that sample.

Total phosphorus and TKN concentrations exceeded the LEL at all sites (except the site east of the harbour entrance 1- 539) and concentrations of both parameters exceeded the SEL at the middle slip site (17-92) and north slip site (17-91) where the highest metal concentrations were detected. Total phosphorus concentrations also exceed the SEL at the mid harbour site.

In general, sediment contamination with metals was low in Wheatly Harbour particularly when concentrations were compared with the PSQGs. However, a comparison of the sediment metal concentrations with background values for the Great Lakes basin suggest enrichment for several parameters (compared with the pre-colonial horizon). Arsenic concentrations were at least two times higher than the background concentrations at all stations sampled and Zn concentrations were also twice as high as the background concentrations at three stations when comparing the data to Persaud et al. (1992). Comparisons with the Mudroch et al. (1988) background concentrations for Lake Erie suggest that the Zn concentrations were within the provided range as were the sediment concentrations of Cr, Cu, Ni and Pb at stations 17-91 and 92. Sediment from stations 17-91 and 17-92 had concentrations of Cr, Cu, Ni and Pb that slightly exceeded the background values provided by Persaud et al. (1992).

In general, the higher concentrations of most metals detected at station 17-91 and 17-92 were due to the greater percentage of fine particulate matter in the sediment samples. Sediment

contaminant data were normalized to Al to determine if contaminant patterns were governed by particles size. Ratios were generally similar between stations for most parameters indicating that patterns of enrichment were not discovered. The only exceptions were for station 1-539 located to the east of the harbour entrance where there was enrichment of As, Ni and Mn.

Organochlorine Pesticides and Chlorinated Benzenes

Chlorinated benzenes were not detected at any sites with the exception of trace concentrations of HCB (2 *u*g/g) at all the slip stations.

Trace concentrations of α-BHC, β-BHC and γ-chlordane were detected sporadically at some stations (Table 20). Trace concentrations (range: 2 to 4 ng/g) of γ-BHC and p'p-DDD (10 ng/g) were detected at all stations with the exception of the site east of the harbour entrance. Concentrations of p'p-DDE greater than the LEL (range: 7 to 30 ng/g) and PCBs (range: 40 to 180 ng/g) were also detected at all stations. Following the patterns of metal contamination the highest concentrations of p'p-DDE and PCBs were present in the north and mid slip (Table 20 & Figure 27). For p'p-DDE, concentrations at these two sites ranged from 17 to 30 ng/g and for total PCBs concentrations ranged from 100 to 180 ng/g. The lowest concentrations of both p'p-DDE and PCBs were present in sediment from the site south of the bridge (17-90) and in the south slip (17-94).

Polycyclic Aromatic Hydrocarbons (PAHs)

Unlike the metals data, the highest PAH concentrations were present in sediment samples collected from the south slip (17-94) and the mid harbour station (17-93) (Table 21). Concentrations of total PAHs were greater than the LEL at only these two stations (mean +/- SD:5.7 *u*g/g +/-2.5 and 6.5 *u*g/g +/- 2.0 respectively). When the data were normalized to TOC these sites showed enrichment relative to the other stations sampled in Wheatley Harbour. The compounds with the highest concentrations included phenanthrene, pyrene and fluoranthene.

Table 19: Concentrations of nutrients, conventional parameters and metals in sediment collected from Wheatley, 1998

Station Description	Station Number		Date YYYYMMDD	Sample Depth (m)	Aluminum ug/g	Arsenic ug/g	Cadmium ug/g	RMK	Chromium ug/g	Copper ug/g	Iron ug/g	Mercury ug/g	RMK	Manganese ug/g	Nickel ug/g	Lead ug/g	RMK	Zinc ug/g	TKN mg/g	RMK	Total Phosphorus mg/g	Loss on Ignition (mg/g)	TOC (mg/g)	RMK	Clay %	RMK	Silt %	RMK	Sand %
Wheatly-east of harbour entrance	1	539	19980820	2.9	3600	7.7	0.5	<T	12	8	12000	0.01	<=W	420	16	7	<T	53	0.1	<=W	0.4	16	1	<=W	0		2	<T	97
	1	539	19980820	3	4000	5.0	0.5	<T	11	8	11000	0.01	<=W	410	13	11		37	0.1	<=W	0.3	12	10		1	<T	2	<T	97
	1	539	19980820	2.8	5100	9.3	0.5	<T	10	10	12000	0.01	<=W	450	16	4	<T	43	0.1	<=W	0.3	13	12		1	<T	2	<T	96
Wheatly-south slip	17	94	19980820	3.3	18000	8.3	1.0		29	40	24000	0.06		410	32	27		120	2.4		1.2	77	39		25		61		13
	17	94	19980820	3.3	19000	7.7	0.9	<T	29	35	24000	0.04	<T	440	32	22		97	1.9		1.1	62	29		28		57		15
	17	94	19980820	3.3	18000	8.3	0.8	<T	28	37	24000	0.05		420	30	20		100	1.6		1.0	69	36		27		58		15
Wheatly-mid-harbour off MNR dock	17	93	19980820	2.4	12000	7.3	0.9	<T	25	32	18000	0.05		420	24	29		96	3.1		4.5**	110	69		9		34		51
	17	93	19980820	2.4	13000	7.1	0.8	<T	23	32	18000	0.05		360	23	24		89	2.7		3.7**	120	55		12		43		38
split	17	93	19980820	2.4	15000	8.7	0.9	<T	24	36	21000	0.07		400	27	27		120	3.5		4.5**	130	68		11		39		44
split	17	93	19980820	2.4	14000	8.3	0.9	<T	27	37	20000	0.06		370	31	32		130	4.6		5.4**	140	70		11		41		45
Wheatly-middle slip	17	92	19980820	1.9	23000	8.9	1.4		38	50	28000	0.09		310	40	30		200	5.1**		2.9**	110	57		26		65		10
	17	92	19980820	1.9	22000	8.1	1.7		38	49	25000	0.08		300	39	29		200	5.2**		3.1**	120	57		23		63		14
	17	92	19980820	1.9	24000	9.1	1.3		38	60	26000	0.11		310	40	31		190	4.3		2.7**	120	59		24		67		9
Wheatly-north slip	17	91	19980820	1.6	24000	7.7	1.4		40	60	24000	0.08		260	40	33		200	6.8**		3.2**	150	71		22		64		14
	17	91	19980820	1.6	26000	8.0	1.1		42	63	26000	0.08		280	42	31		190	6.0**		3.1**	140	66		25		65		9
	17	91	19980820	1.6	25000	7.1	1.4		43	52	26000	0.06		280	42	27		190	6.9**		3.6**	150	75		22		62		17
Wheatly-south of Bridge	17	90	19980820	2.4	6300	3.2	0.2	<=W	14	15	11000	0.01	<=W	210	13	13		47	4.7		1.0	31	22		4		11		76
	17	90	19980820	2.4	8000	4.2	0.5	<T	16	19	13000	0.02	<T	210	16	20		76	1.2		1.2	47	27		6		15		73
	17	90	19980820	2.4	6500	3.9	0.3	<T	14	17	11000	0.03	<T	200	14	21		62	0.8		1.1	35	24		5		13		74
Lowest Effect Level (ug/g)						6	0.6		26	16	20000	0.2		460	16	31		120	0.55 mg/g		0.6 mg/g		10 mg/g						
Severe Effect Level (ug/g) **						33	10		110	110	40000	2		1100	75	250		820	4.8 mg/g		2.0 mg/g		100 mg/g						
Background - Great Lakes pre-colonial sediment horizon, Persaud et al. (1992)						4.2	1.1		31	25	31000	0.1		400	31	23		65											
Background - Lake Erie pre-colonial sediment horizon for Harbours (H) and/or depositional zones (D), Mudroch et al. (1988)						0.5-1.2 (H)	0.1 (H) 0.1-1.7(D)		30-250(H) 9-25(D)	10-110(H) 20-48(D)	1000-15000(H) 8900-48200(D)	0.05-7(H)			55-65(H) 10-76(D)	21-49(D)		40-500(H) 8-128(D)											

<W no measurable response
<T measurable trace amount, interpret with caution
<=> approximate value

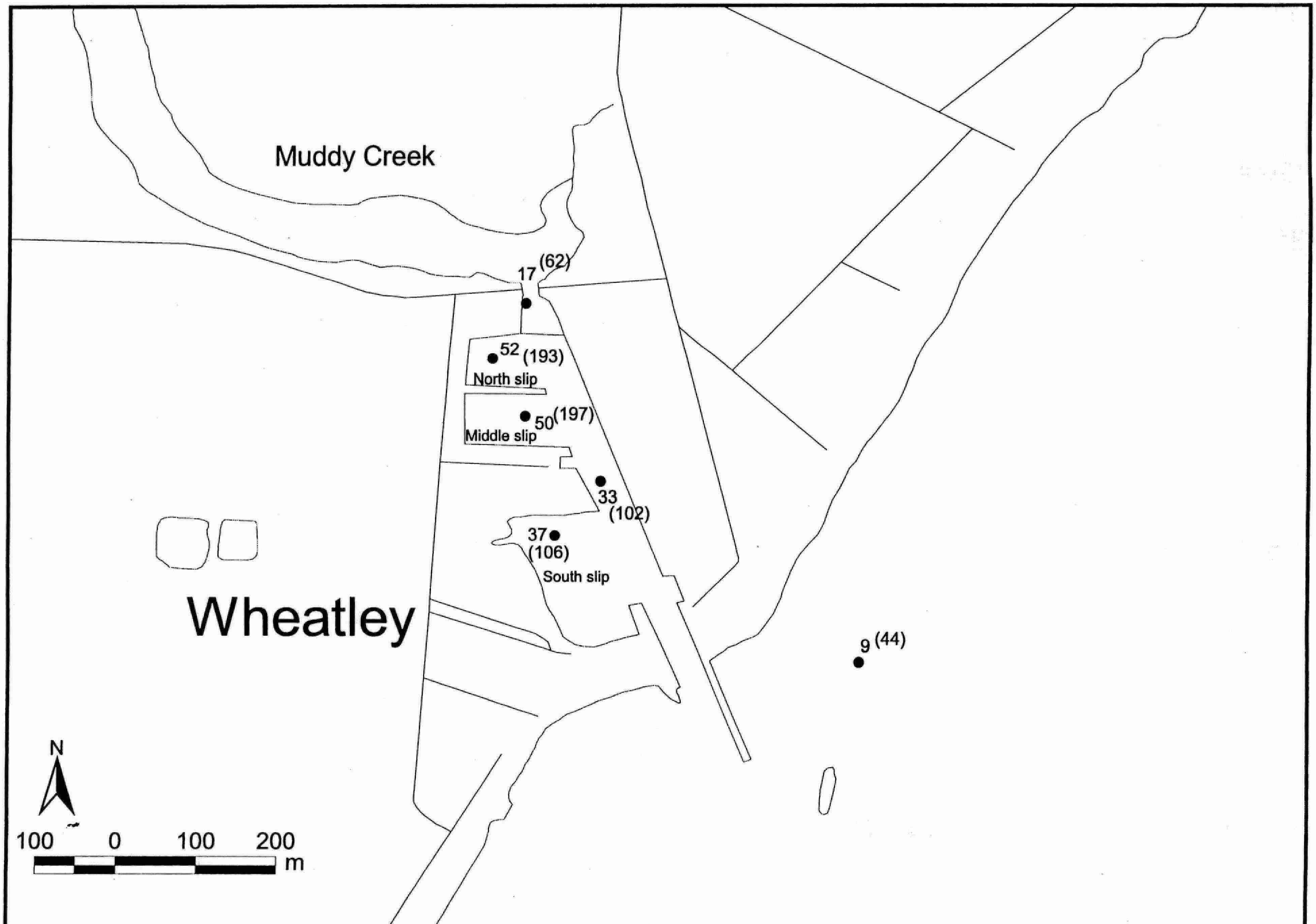


Figure 26: Sediment Copper (and Zinc) Concentrations (ug/g), Wheatley Harbour, 1998

Table 20: Concentrations of chlorinated organic parameters in sediment collected from Wheatley, 1998

Station Description	Station Number		Date	HCB ng/g	RMK	a-BHC ng/g	RMK	b-BHC ng/g	RMK	g-BHC ng/g	RMK	Chlordane ng/g	RMK	Total PCB ng/g	RMK	p'p-DDD ng/g	RMK	p'p-DDE ng/g	RMK
Wheatly-south slip	17	94	19980820	2	<T					3	<T			100	P40	10	<T	15	
	17	94	19980820	2	<T									40	P40			7	<T
	17	94	19980820	2	<T							4	<T	80	P40			13	
Wheatly-mid-harbour off MNR dock	17	93	19980820	2	<T			2	<T	2	<T			100	P40	10	<T	17	
	17	93	19980820	2	<T	6	<T							180	P40			27	
split	17	93	19980820							4	<T			100	P40	10	<T	20	
split	17	93	19980820							2	<T			100	P40	10	<T	22	
Wheatly-middle slip	17	92	19980820	2	<T					4	<T			120	P40	10	<T	23	
	17	92	19980820	2	<T	2	<T							100	P40	10	<T	17	
	17	92	19980820	2	<T									140	P40	10	<T	21	
Wheatly-north slip	17	91	19980820	2	<T					2	<T			160	P40	10	<T	21	
	17	91	19980820	4	<T					3	<T			180	P40	10	<T	30	
	17	91	19980820	2	<T	2	<T	2	<T	2	<T			160	P40	10	<T	29	
Wheatly-south of Bridge	17	90	19980820	2	<T					3	<T			60	P40			10	
	17	90	19980820	2	<T					2	<T			60	P40			11	
	17	90	19980820											80	P40	10	<T	12	
Lowest Effect Level (ng/g)				**20**		**6**		**5**		**3***		**7**		**70**		**8**		**5**	

<W no measurable response

<T measurable trace amount, interpret with caution

<=> approximate value

P40 PCB resembles mixture of aroclor 1254 and 1260

* - 10% of screening level concentration

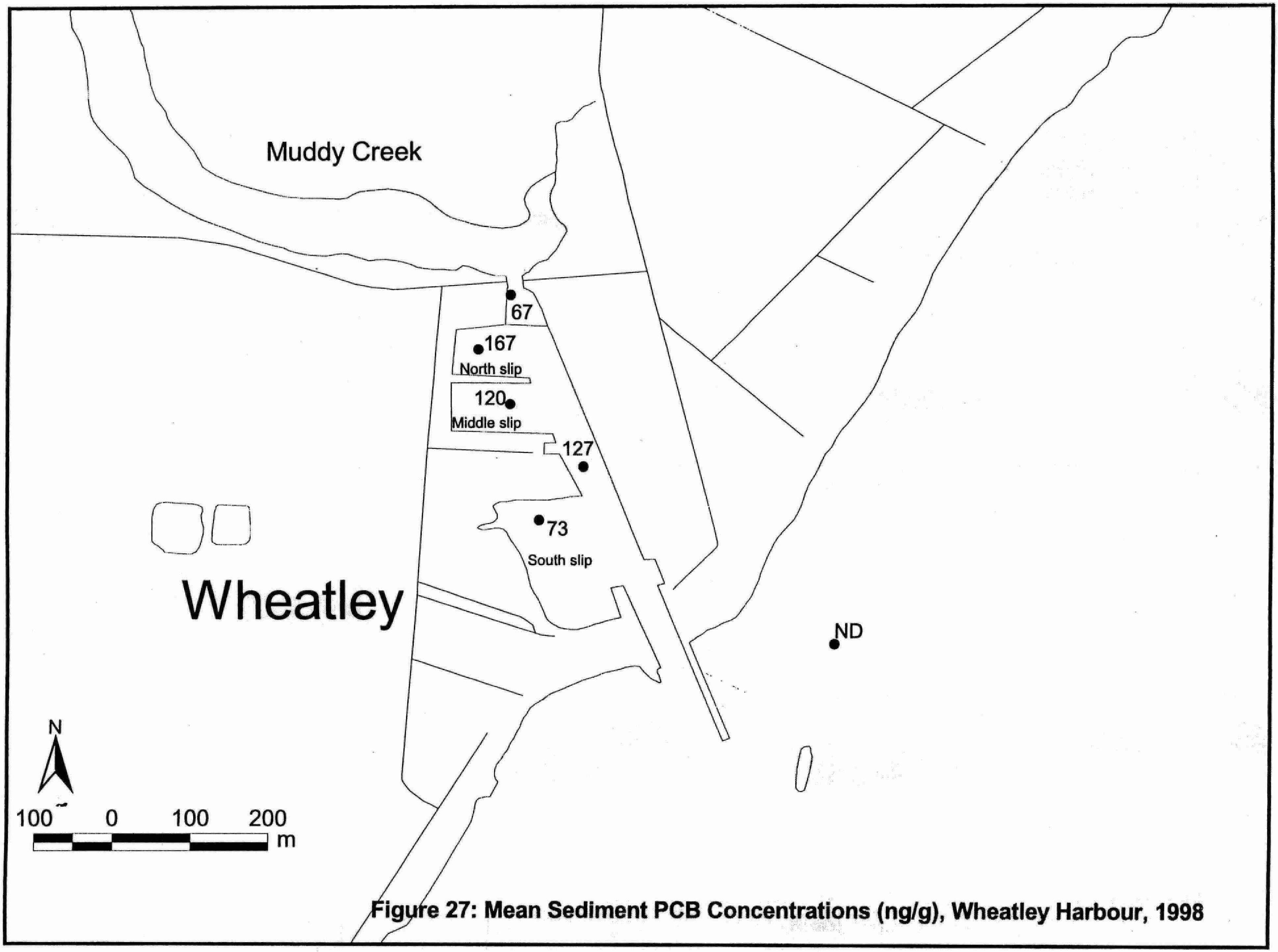


Figure 27: Mean Sediment PCB Concentrations (ng/g), Wheatley Harbour, 1998

Table 21: Concentrations of polycyclic aromatic hydrocarbons (ng/g) in sediment collected from Wheatly Harbour, 1998

Station Description	Station Number	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b) fluoranthene	Benzo(k) fluoranthene	Chrysene	Dibenzo(ah) anthracene
Wheatly-east of harbour entrance	1 539	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	1 539	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	1 539	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Wheatly-south slip	17 94	100	40 <T	80 <T	340	320	420	300	440	80 <T
	17 94	20 <=W	40 <T	40 <T	160	160 <T	220	160	260	120 <T
	17 94	120	60 <T	140	420	400	480	380	540	160 <T
Wheatly-mid-harbour off MNR dock	17 93	160	40 <T	220	540	440	540	400	560	80 <T
	17 93	60 <T	60 <T	80 <T	380	360	460	360	460	80 <T
split	17 93	80 <T	40 <T	80 <T	280	280	340	240	360	40 <=W
split	17 93	60 <T	40 <T	60 <T	300	280	380	280	380	40 <=W
Wheatly-middle slip	17 92	20 <=W	20 <=W	20 <=W	120	120 <T	180	120	160	40 <=W
	17 92	20 <=W	20 <=W	20 <=W	120	120 <T	160	120	160	40 <=W
	17 92	20 <=W	20 <=W	20 <=W	120	120 <T	180	120	160	40 <=W
Wheatly-north slip	17 91	20 <=W	20 <=W	20 <=W	140	160 <T	200	140	180	40 <=W
	17 91	20 <=W	20 <=W	20 <=W	100	120 <T	140	100	140	40 <=W
	17 91	20 <=W	20 <=W	20 <=W	80 <T	80 <T	140	100	120	40 <=W
Wheatly-south of Bridge	17 90	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	40 <T	20 <=W	40 <T	40 <=W
	17 90	20 <=W	20 <=W	20 <=W	40 <T	40 <=W	40 <T	40 <T	60 <T	40 <=W
	17 90	100	20 <=W	40 <T	40 <T	40 <=W	60 <T	40 <T	60 <T	40 <=W
Lowest Effect Level (ng/g)				220	320	370		240	340	60

Station Description	Station Number	Fluoranthene	Fluorene	Benzo(g,h,I) perylene	Indeno(1,2,3-cd) pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH
Wheatly-east of harbour entrance	1 539	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	20 <=W	40
	1 539	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	20 <=W	40
	1 539	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	60 <T	20 <=W	60
Wheatly-south slip	17 94	1200	100	200	200	60 <T	1100	960	5940
	17 94	580	40 <T	120 <T	120 <T	20 <=W	480	560	3080
	17 94	1700	200	280	280	80 <T	1400	1400	8040
Wheatly-mid-harbour off MNR dock	17 93	2100	260	280	280	80 <T	1900	1500	9380
	17 93	1400	80 <T	240	240	40 <T	860	1100	6260
split	17 93	1100	100	160 <T	160 <T	40 <T	900	920	5080
split	17 93	1200	80 <T	200	200	40 <T	800	940	5240
Wheatly-middle slip	17 92	400	20 <=W	120 <T	80 <T	40 <T	300	400	2040
	17 92	420	20 <=W	80 <T	80 <T	20 <=W	300	400	1960
	17 92	440	40 <T	80 <T	80 <T	20 <=W	340	440	2120
Wheatly-north slip	17 91	580	20 <=W	120 <T	120 <T	20 <=W	260	480	2380
	17 91	360	20 <=W	80 <T	80 <T	20 <=W	200	340	1660
	17 91	320	20 <=W	80 <T	80 <T	20 <=W	200	300	1500
Wheatly-south of Bridge	17 90	180	20 <=W	40 <=W	40 <=W	20 <=W	200	140	600
	17 90	200	20 <=W	40 <=W	40 <=W	20 <=W	180	200	760
	17 90	300	120	40 <=W	40 <=W	20 <=W	500	220	1480
Lowest Effect Level (ng/g)		750	190	170	200		560	490	4000
						Severe Effect Level (ng/g organic carbon)			10,000

<W no measurable response
<T measurable trace amount, interpret with caution

LEAMINGTON

There are no direct inputs to the Leamington Harbour. However, the WPCP outfall discharges to Lake Erie and is located to the east of the harbour. The harbour includes a large marina and developed parkland. Storm sewers discharge to Lake Erie west of the harbour and to the mouth of the harbour from the breakwall.

Although water samples were not collected from Leamington Harbour, five stations were investigated for sediment contamination. Two stations were located inside the harbour (stations 17-59 and 17-60) (Figure 28). One station was at the harbour entrance (station 17-61) and two stations were outside the harbour in the nearshore area (station 01-1357 and 01-1363). Station 01-1363 was located near the WPCP outfall.

All sediment data are provided in Tables 22 to 24 and in Figure 29 following the description and interpretation of the data for Leamington.

Sediment Quality

Sediment Physical Qualities

The station located near the WPCP (station 01-1363), at the entrance to the harbour (station 17-61) and the inner harbour site (station 17-60) were characterized as silty sand with some clay (<14%) while the other harbour station (17-59) and the lake site (01-1357) were high in percent sand (> 73 % and >93% sand respectively). TOC concentrations were greater than the LEL at all stations with the exception of 17-59. The highest TOC concentration was in sediment from station 17-61 (range: 31 to 39 mg/g). All remaining stations had concentrations that were less than 17 mg/g. LOI concentrations were low at all stations. The highest concentrations were at station 17-61 with a range from 48 to 53 mg/g.

Metals and Nutrients

The LEL was exceeded for As, Cd, Cu, Ni, TP and TKN at station 17-61 (the entrance to the harbour)(Figure 29). The highest concentrations of Hg, Pb and Zn were also present at this site compared with sediment concentrations at the other sampling stations but concentrations were less than the LEL. Copper concentrations were also greater than the LEL at station 17-60 and TP concentrations were greater than the LEL at station 17-59 and for one sample at station 01-1363 (near the WPCP outfall). TKN concentrations were less than the reportable minimum value at most stations.

In general sediment contamination with metals was low in the harbour and at the lake site. The high sand content in some of the samples likely had a major influence on the metal concentrations. With the exception of As, metal concentrations were typically below the Great Lakes background concentrations or within the range for Lake Erie background concentrations.

Organochlorine Pesticides and Chlorinated Benzenes

Chlorinated benzenes were not detected in any sediment samples. α-BHC, was detected at one site (station 01-1363 (range <W to 29 ng/g) and γ-BHC and γ-chlordane were detected in one sample from station 17-61 at trace concentrations (Table 23).

Both p'p-DDE and p'p-DDD were detected at stations 17-60 and 17-61 at low concentrations (6 to 10 ng/g) and p'p-DDT was detected in one sample at trace concentrations at station 17-61. p'p-DDE was also detected at trace concentrations at stations 01-1363 (3 to 6 ng/g) and 01-1357 (< 3 ng/g).

Total PCBs were detected at low concentrations in samples collected from stations 60, 61 and from the station near the WPCP (station 1363). Concentrations ranged from 40 to 80 ng/g.

Polycyclic Aromatic Hydrocarbons (PAHs)

Sediment concentrations of total PAHs were greater that the LEL in two samples from station 17-61 located at the harbour entrance (4.3 *ug*/g and 5.6 *ug*/g) (Table 24). Sediment concentrations of total PAHs were below the LEL at all remaining stations and ranged from 0.08 to 1.0 *ug*/g. PAHs were not detected in sediment collected from station 17-59. This was likely due to the high sand content of the sample (>93% sand).

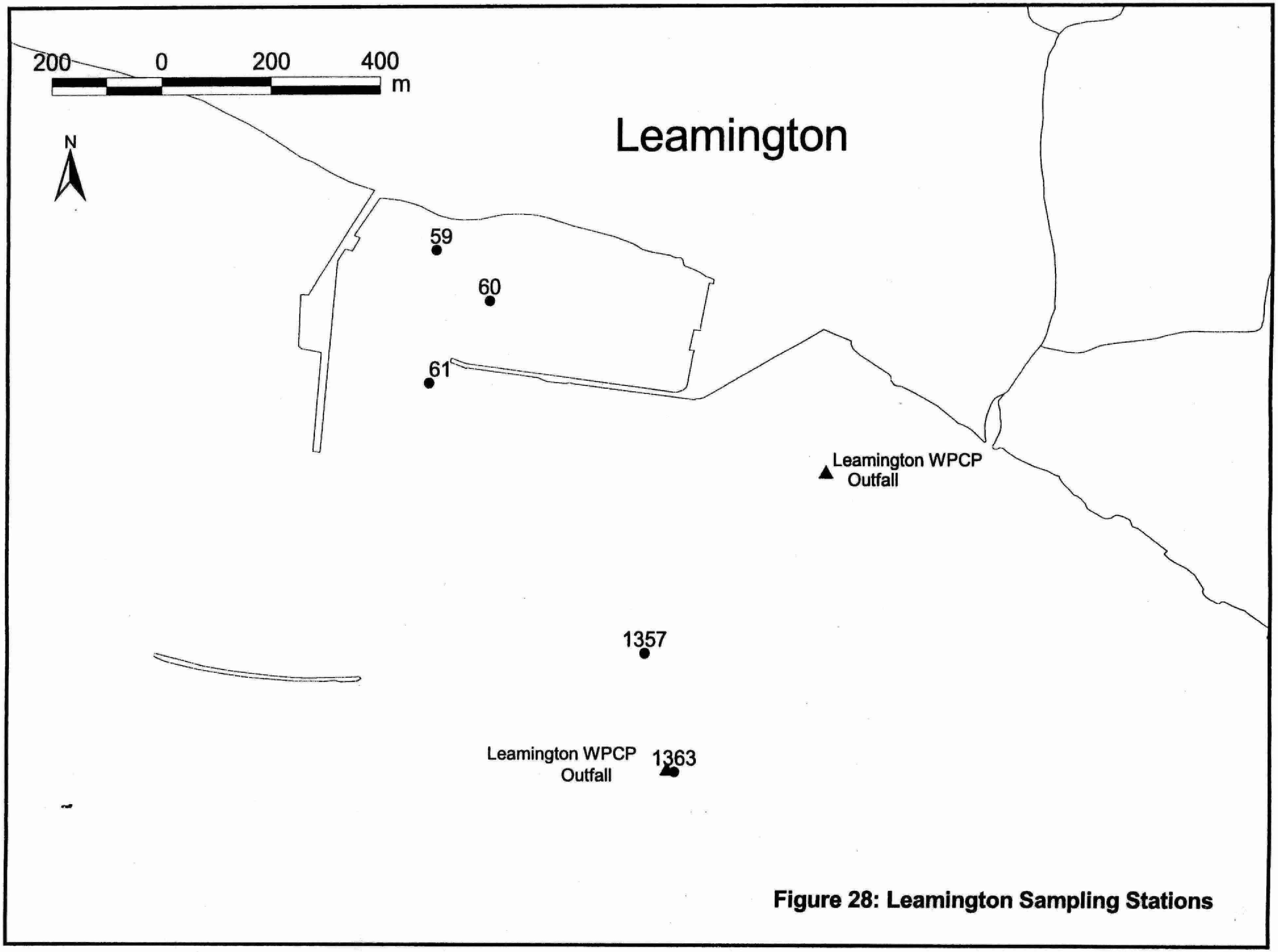


Figure 28: Leamington Sampling Stations

Table 22: Concentrations of nutrients, conventional parameters and metals in sediment collected from Leamington, 1998

Station Description	Station Number		Date YYYYMMDD	Sample Depth (m)	Aluminum ug/g	Arsenic ug/g	Cadmium ug/g	RMK	Chromium ug/g	Copper ug/g	RMK	Iron ug/g	Mercury ug/g	RMK	Manganese ug/g	RMK	Nickel ug/g	Lead ug/g	RMK	Zinc ug/g	RMK	TKN mg/g	RMK	Total Phosphorus mg/g	Loss on Ignition (mg/g)	TOC (mg/g)	RMK	Clay %	Silt %
Leamington-WPCP outfall	1	1363	19980819	7.2	4900	3.3	0.5	<T	12	13		11000	0.04	<T	340		9	7	<T	44		0.1	<=W	0.5	11	9		7	42
	1	1363	19980819	7.3	4400	3.2	0.2	<=W	12	13		9600	0.04	<T	330		9	12		41		0.1	<=W	0.6	9	10		7	42
	1	1363	19980819	7.4	4700	3.5	0.5	<T	11	13		11000	0.07		340		9	7	<T	42		0.1	<=W	0.6	11	9		7	43
Leamington-Harbour	17	60	19980819	2.9	6500	4.1	0.4	<T	13	15		12000	0.06		300		13	9	<T	46		0.4	<T	0.5	18	11		13	37
	17	60	19980819	2.9	7200	4.7	0.5	<T	14	19		12000	0.06		320		13	11		54		0.3	<T	0.5	20	17		14	41
split	17	60	19980819	3	7300	4.3	0.3	<T	13	17		12000	0.02	<T	310		14	13		55		0.3	<T	0.5	20	14		13	37
split	17	60	19980819	3	7100	4.5	0.4	<T	13	17		12000	0.03	<T	310		15	11		60		0.4	<T	0.6	20	15		15	41
Leamington-Harbour (NW corner)	17	59	19980819	1.7	2800	2.5	0.2	<=W	11	4	<T	12000	0.01	<=W	220		5	6	<T	31		0.1	<=W	0.6	5	1	<=W	2	5
	17	59	19980819	1.9	2700	2.1	0.2	<=W	10	3	<T	11000	0.01	<=W	210		5	5	<T	32		0.1	<=W	0.6	5	3	<T	1	4
	17	59	19980819	1.8	2600	2.2	0.2	<=W	8	3	<T	9900	0.01	<=W	190		5	2	<=W	21	<T	0.1	<=W	0.5	4	2	<T	1	4
Leamington-Harbour entrance	17	61	19980819	5.4	8900	7.3	0.6	<T	17	30		15000	0.06		390		22	17		76		1.2		0.6	53	34		14	55
	17	61	19980819	5.4	8600	6.6	0.6	<T	17	28		14000	0.05		380		20	14		73		1.2		0.7	48	39		13	53
	17	61	19980819	5.5	8100	6.3	0.7	<T	16	30		14000	0.10		380		20	18		75		1.4		0.6	52	31		14	57
Leamington offshore from marina	1	1357	19980819	7.3	4500	5.8	0.2	<=W	10	11		11000	0.02	<T	310		9	9	<T	100		0.1	<=W	0.4	14	12		3	9
	1	1357	19980819	7.2	4200	5.4	0.2	<=W	10	10		10000	0.03	<T	270		9	4	<T	32		0.1	<=W	0.4	13	4	<T	3	10
	1	1357	19980819	7.2	4400	4.6	0.7	<T	13	9		15000	0.01	<=W	350		11	7	<T	41		0.1	<=W	0.4	12	11		3	11
Lowest Effect Level (ug/g)						6	0.6		26	16		20000	0.2		460		16	31		120		0.55 mg/g		0.6 mg/g		10 mg/g			
Severe Effect Level (ug/g) **						33	10		110	110		40000	2		1100		75	250		820		4.8 mg/g		2.0 mg/g		100 mg/g			
Background - Great Lakes pre-colonial sediment horizon, Persaud et al. (1992)						4.2	1.1		31	25		31000	0.1		400		31	23		65									
Background - Lake Erie pre-colonial sediment horizon for Harbours (H) and/or depositional zones (D), Mudroch et al. (1988)						0.5-1.2 (H)	0.1 (H) 0.1-1.7(D)		30-250(H) 9-25(D)	10-110(H) 20-48(D)		1000-15000(H) 8900-48200(D)	0.05-7(H)				55-65(H) 10-76(D)	21-49(D)		40-500(H) 8-128(D)									

<W no measurable response

<T measurable trace amount, interpret with caution

<=> approximate value

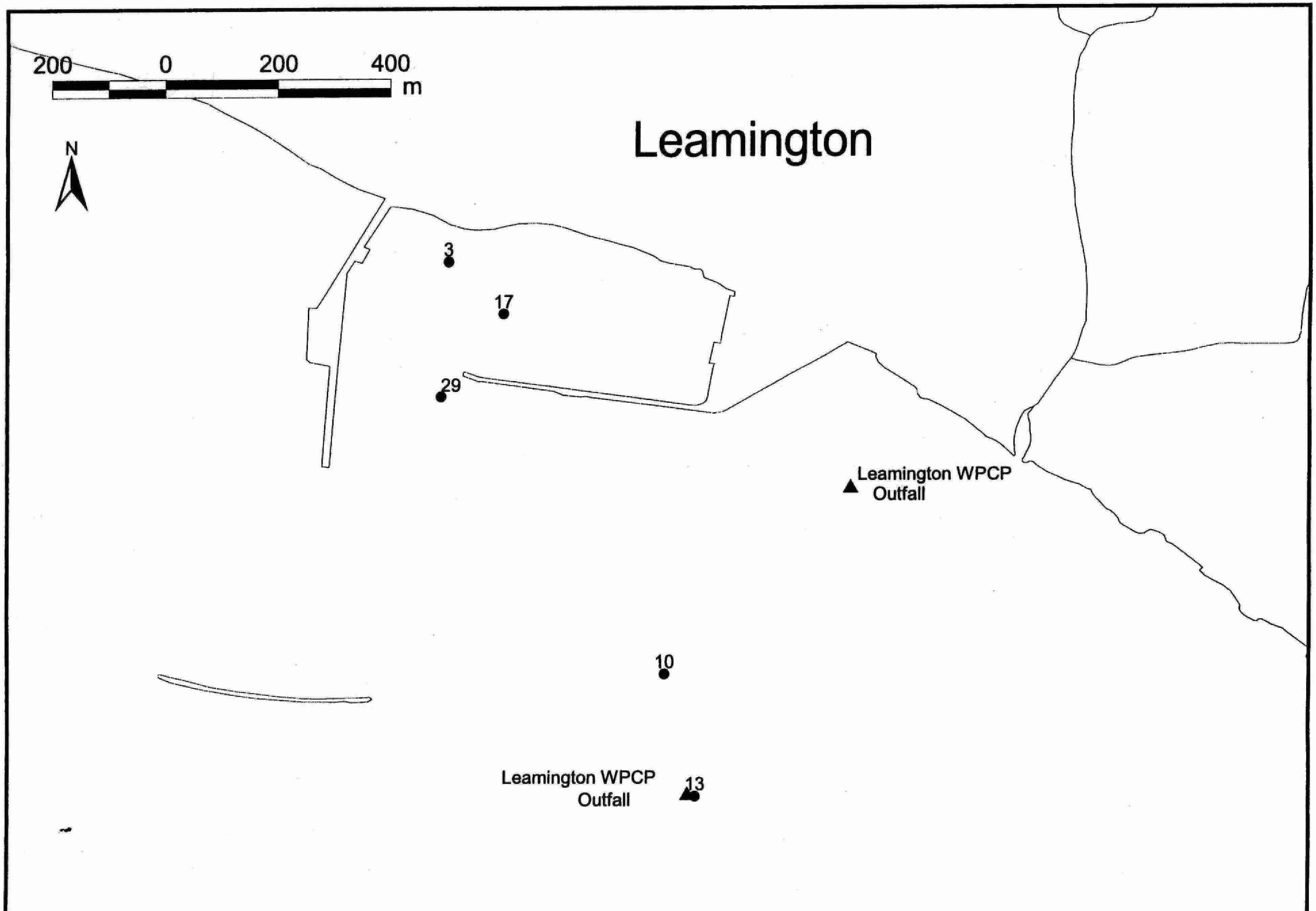


Figure 29: Sediment Copper Concentrations (ug/g), Leamington, 1998

Table 23: Concentrations of chlorinated organic parameters in sediment collected from Leamington, 1998

Station Description	Station Number		Date	HCB ng/g	RMK	a-BHC ng/g	RMK	g-BHC ng/g	RMK	Chlordane ng/g	RMK	o'p-DDT ng/g	RMK	Total PCB ng/g	RMK	p'p-DDD ng/g	RMK	p'p-DDE ng/g	RMK	p'p-DDT ng/g	RMK
Leamington-WPCP outfall	1	1363	19980819	2		29								40	P40			4	<T		
	1	1363	19980819	2	<T	7	<T							40	P40			4	<T		
	1	1363	19980819	2	<T									40	P40			3	<T		
Leamington-Harbour	17	60	19980819	2	<T									40	P40	10	<T	6	<T		
	17	60	19980819									10	<T	40	P40			6	<T		
split	17	60	19980819	2	<T									60	P40	10	<T	8	<T		
split	17	60	19980819	2	<T									40	P40	10	<T	6	<T		
Leamington-Harbour (NW corner)	17	59	19980819											20	<=W						
Leamington-Harbour entrance	17	61	19980819	3	<T									80	P40	15	<T	9	<T		
	17	61	19980819	3	<T					4	<T			60	P40	10	<T	8	<T		
	17	61	19980819	5	<T			2	<T					80	P40	10	<T	10		15	<T
Leamington offshore from marina	1	1357	19980819															2	<T		
	1	1357	19980819															3	<T		
Lowest Effect Level (ng/g)				20		6		3*		7		8		70		8		5		8	

<W no measurable response
<T measurable trace amount, interpret with caution
<=> approximate value
P40 PCB resembles mixture of aroclor 1254 and 1260
* - 10% of screening level concentration

Table 24: Concentrations of polycyclic aromatic hydrocarbons (ng/g) in sediment collected from Leamington, 1998

Station Description	Station Number		Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b) fluoranthene	Benzo(k) fluoranthene	Chrysene	Dibenzo(ah) anthracene
Leamington-WPCP outfall	1	1363	20 <=W	20 <=W	20 <=W	40 <T	40 <=W	40 <T	20 <=W	60 <T	40 <=W
	1	1363	20 <=W	20 <=W	20 <=W	60 <T	80 <T	60 <T	60 <T	80 <T	40 <=W
	1	1363	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	40 <T	40 <=W
Leamington-Harbour	17	60	20 <=W	20 <=W	20 <=W	80 <T	80 <T	80 <T	60 <T	120	40 <=W
	17	60	20 <=W	20 <=W	60 <T	140	120 <T	120	120	180	40 <=W
split	17	60	20 <=W	20 <=W	60 <T	160	120 <T	120	120	200	40 <=W
split	17	60	20 <=W	20 <=W	20 <=W	80 <T	80 <T	80 <T	60 <T	120	40 <=W
Leamington-Harbour (NW corner)	17	59	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
Leamington-Harbour entrance	17	61	40 <T	40 <T	140	440	440	480	400	520	40 <=W
	17	61	40 <T	40 <T	120	420	360	380	320	480	40 <=W
	17	61	20 <=W	20 <=W	80 <T	260	240	240	200	320	40 <=W
Leamington offshore from marina	1	1357	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	40 <T	40 <=W
	1	1357	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	20 <=W	40 <=W
	1	1357	20 <=W	20 <=W	20 <=W	20 <=W	40 <=W	20 <=W	20 <=W	40 <T	40 <=W
Lowest Effect Level (ng/g)					220	320	370		240	340	60

Station Description	Station Number		Fluoranthene	Fluorene	Benzo(g,h,l) perylene	Indeno(1,2,3-cd) pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH
Leamington-WPCP outfall	1	1363	80 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	80 <T	340
	1	1363	140	20 <=W	40 <=W	40 <=W	20 <=W	80 <T	120	680
	1	1363	60 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	60 <T	200
Leamington-Harbour	17	60	160	20 <=W	40 <=W	40 <=W	20 <=W	80 <T	140	800
	17	60	280	20 <=W	80 <T	80 <T	20 <=W	120	240	1540
split	17	60	360	20 <=W	80 <T	80 <T	20 <=W	260	300	1860
split	17	60	200	20 <=W	80 <T	40 <=W	20 <=W	100	180	980
Leamington-Harbour (NW corner)	17	59	20 <=W	20 <=W	40 <=W	40 <=W	20 <=W	20 <=W	20 <=W	0
Leamington-Harbour entrance	17	61	960	80 <T	320	280	80 <T	620	800	5640
	17	61	700	40 <T	200	200	60 <T	340	620	4320
	17	61	540	40 <T	160 <T	120 <T	60 <T	320	480	3060
Leamington offshore from marina	1	1357	60 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	60 <T	200
	1	1357	40 <T	20 <=W	40 <=W	40 <=W	20 <=W	40 <T	20 <=W	80
	1	1357	60 <T	20 <=W	40 <=W	40 <=W	20 <=W	80 <T	60 <T	240
Lowest Effect Level (ng/g)			750	190	170	200		560	490	4000
							Severe Effect Level (ng/g organic carbon)			10,000

<W no measurable response

<T measurable trace amount, interpret with caution

POLYCHLORINATED DIBENZO-P-DIOXINS AND POLYCHLORINATED DIBENZO FURANS

The highest concentrations of dioxins and furans were present in sediment collected from Wheatley Harbour (Table 25). The TEQ (concentration of toxicity equivalents using the World Health Organization TEFs from August 1997) at two stations in the harbour was 11.2 and 17.8 pg/g compared with TEQs from the remaining harbours which were all less than 4 pg/g. The TEQ for Wheatley was similar to the TEQ calculated for sediment collected from Fort Erie in 1997 at the head of the Niagara River (Richman 1999) and although higher than the other harbours in Lake Erie is still consistent with other industrialized areas in the Great Lakes.

Octachlorodioxin was present at the highest concentrations in all harbour sediment compared with other congener groups. In general, the higher chlorinated dioxin congeners were present at higher concentrations than the furans and lower chlorinated dioxins. Concentrations of 2,3,7,8 TCDD (the most toxic form of dioxin) were below the detection limit in sediment from most harbours. The only exceptions were low concentrations in sediment from Wheatley (0.9 pg/g) and Leamington (0.7 pg/g).

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TABLE 25: Concentrations of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans in sediment from Lake Erie, harbours and embayments 1998. Concentrations are in pg/g (dry weight). n=1

Station	Port Maitland Harbour		Port Dover Lynn River		Nanticoke Creek (mouth)		Port Bruce Catfish Creek		Port Burwell Big Otter Creek		Port Stanley Kettle Creek		Wheatly South Slip		Wheatly Middle Slip		Leamington Harbour	
Station Number	17-54	**	15-70		15-72		15-65		15-71		15-67		17-94		17-92		17-60	
T4CDD (total)	7.1	I4	23	I4	0.94	I4	0.6	I3	0.54	I2	1.2	I4	7	I11	3	<	5	I8
P5CDD (total)	4.6	I7	5.1	I6	0.77	I2	1.4	I3	0.7	I2	3.5	I6	6.8	I4	9.3	I4	5	I6
H6CDD (total)	23	I6	22	I6	2.3	I2	3	I3	5.9	I5	9.2	I7	51	I7	68	I5	21	I7
H7CDD (total)	75	I2	94	I2	10	I2	11	I2	34	I2	27	I2	290	I2	470	I2	54	I2
O8CDD (total)	510		400		36		38		96		100		5500		9200		390	
T4CDF (total)	15	I18	12	I18	6.4	I17	2.8	I18	3.1	I18	6.1	I18	24	I18	30	I16	29	I18
P5CDF (total)	15	I13	17	I10	2.8	I6	2.5	I6	1.7	I3	9.8	I8	21	I11	24	I4	18	I13
H6CDF (total)	10	I7	17	I9	1.4	I5	2	I3	2.1	I4	8.1	I7	15	I10	12	I2	10	I8
H7CDF (total)	18	I4	38	I4	1.8	I3	4.6	I4	5.6	I4	11	I4	15	I4	27	I3	11	I4
O8CDF (total)	14		55		3.7		4.6		6.4		13		14		23		7.7	
2378T4CDF	1.6		1.3		0.73		0.45		0.45		0.81		3.9		4.2		4.8	
2378T4CDD	0.3	<	0.1	<	0.1	<	0.2	<	0.1	<	0.2	<	0.9		1	<	0.7	
12378P5CDF	0.6	<	0.6	<	0.3	<	0.2	<	0.2	<	0.5	<	0.9	<	0.6	<	1.2	
23478P5CDF	0.87		0.68		0.3		0.3	<	0.23		0.58		1.6		2	<	1.5	
12378P5CDD	0.8	<	1	<	0.5	<	0.5	<	0.4	<	0.7	<	1	<	2.1		0.9	<
123478H6CDD	1.5		1.6		0.4	<	0.5	<	0.4	<	1.3		1.8		3	<	2.2	
123678H6CDD	1	<	1	<	0.5	<	0.4	<	0.4	<	1	<	1	<	2	<	1	<
234678H6CDF	1	<	1		0.4	<	0.4	<	0.4	<	0.7	<	1.1		2	<	0.9	<
123789H6CDF	0.9	<	1	<	0.9	<	0.9	<	0.8	<	0.9	<	0.8	<	1	<	0.8	<
123478H6CDF	0.9	<	1	<	0.04	<	0.5	<	0.5	<	0.6	<	2.2		4	<	0.8	<
123678H6CDF	2.7		3		0.4	<	0.4	<	0.62		0.88		3.7		6	<	1.7	
123789H6CDD	1.6		2.6		0.4	<	0.4	<	0.59		1		5.6		9.6		1.9	
1234678H7CDF	7.7		15		2	<	2		2.2		5.2		6.4		12		5.5	
1234789HCDF	0.57		0.96		0.18		0.18		0.19		0.45		0.54		1.4		0.49	
1234678H7CDD	38		58		5.4		6.3		14		15		140		220		25	
TEQ pg/g	3.3		3.4		1.0		1.1		1.1		1.9		11.2		17.8		4.1	
TOC mg/g	18		12		16		12		11		12		39		56		11	

i Number of isomers detected in the congener group

< Compound was below the detection limit

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APPENDIX

Appendix A: Estimated mean daily discharge (m3/s) for harbours and tributaries based on flow measurements from upstream gauging stations, 1998. Shaded areas represent sampling days.

Mean Daily Discharge (m^3/s)

Date	Port Dover Lynn River	Port Maitland Grand River	Thames River	Port Bruce Catfish Creek	Port Stanley Kettle Creek	Port Burwell Big Otter Creek	Nanticoke Creek
19980101	3.3	38.8	42.2	2.8	3.1	6.7	2.0
19980102	3.4	41.6	35.1	2.3	1.9	6.3	1.7
19980103	3.8	49.7	34.8	2.5	2.1	6.8	1.7
19980104	5.1	70.2	38.8	11.0	14.4	9.3	4.1
19980105	5.2	145.0	94.6	14.9	19.8	21.1	5.0
19980106	6.6	226.9	202.4	34.4	38.6	32.0	8.5
19980107	7.1	339.0	269.5	25.0	25.5	37.2	10.2
19980108	13.0	468.7	451.8	89.7	92.7	57.4	25.9
19980109	11.5	526.2	486.2	51.0	49.3	71.4	21.0
19980110	9.2	480.4	438.5	26.3	26.7	70.6	13.9
19980111	7.0	362.8	391.9	11.5	11.3	46.5	8.0
19980112	5.3	240.7	307.3	6.7	6.4	26.7	6.0
19980113	6.3	168.8	184.2	5.9	5.2	19.3	4.8
19980114	5.5	120.7	105.8	4.5	4.0	15.5	4.0
19980115	5.1	88.8	77.7	3.7	3.3	13.6	3.5
19980116	4.8	72.8	64.5	3.3	2.9	11.9	3.1
19980117	4.7	66.2	57.4	2.9	2.6	10.5	2.8
19980118	4.6	60.0	51.3	2.7	2.3	9.7	2.5
19980119	4.5	54.9	47.2	2.5	2.1	9.0	2.2
19980120	4.3	51.3	44.1	2.3	1.9	8.3	2.0
19980121	4.2	48.9	42.6	2.2	1.8	7.8	1.8
19980122	4.2	45.7	40.6	2.0	1.8	7.6	1.6
19980123	4.4	43.0	40.6	2.1	1.7	7.3	1.5
19980124	4.4	45.0	41.4	2.5	1.8	7.5	1.6
19980125	4.2	50.2	41.0	2.2	1.8	7.3	1.6
19980126	4.1	46.5	39.5	2.0	1.7	6.9	1.5
19980127	4.0	44.9	37.9	1.9	1.5	6.6	1.4
19980128	4.0	44.0	37.4	2.0	1.6	6.4	1.4
19980129	4.5	43.1	43.5	2.2	1.8	6.6	1.6
19980130	5.1	42.8	58.6	4.0	3.2	8.5	2.6
19980131	4.8	43.6	56.7	3.9	3.8	8.5	2.9
19980201	4.6	47.8	52.1	3.5	3.4	7.8	2.7
19980202	4.5	46.9	55.7	3.6	3.3	7.5	3.1
19980203	4.7	45.6	69.9	4.6	4.7	7.9	3.6
19980204	4.5	45.1	48.7	3.8	4.3	7.8	2.9
19980205	4.2	46.4	43.7	2.9	3.4	7.2	2.0
19980206	3.9	42.5	37.6	2.3	2.7	6.4	1.8
19980207	3.8	40.1	34.3	2.2	2.3	6.1	1.7
19980208	3.7	38.4	32.4	2.1	2.0	5.8	1.6
19980209	3.7	36.9	31.1	2.0	1.8	5.6	1.5
19980210	3.7	36.8	28.8	2.4	2.0	5.5	1.4
19980211	3.9	37.2	31.3	2.7	2.4	5.7	1.7
19980212	4.6	40.4	43.2	7.6	6.3	8.3	3.3
19980213	4.6	41.0	49.7	7.7	8.5	10.4	3.5
19980214	4.1	44.7	45.5	4.3	5.0	9.3	3.2
19980215	3.8	47.8	40.6	3.4	3.6	7.7	2.9
19980216	3.7	44.1	36.9	2.6	2.9	6.7	2.8
19980217	7.3	57.1	63.8	24.3	17.2	11.4	5.2
19980218	15.9	126.9	266.9	71.3	75.1	48.5	19.1

Date	Port Dover Lynn River	Port Maitland Grand River	Thames River	Port Bruce Catfish Creek	Port Stanley Kettle Creek	Port Burwell Big Otter Creek	Nanticoke Creek
19980219	9.4	184.2	238.7	31.0	32.9	55.2	17.5
19980220	8.0	241.5	230.0	21.2	21.9	49.0	11.9
19980221	7.3	220.9	208.3	18.0	19.3	41.5	10.2
19980222	6.7	187.4	177.4	12.8	13.4	34.6	8.3
19980223	6.1	148.7	146.2	9.8	11.0	27.7	6.8
19980224	5.9	129.7	120.8	7.9	9.1	22.9	5.6
19980225	5.6	119.5	101.1	6.2	7.3	19.8	4.5
19980226	5.3	112.0	88.0	5.0	5.9	17.0	3.8
19980227	5.1	116.2	77.7	4.3	5.0	15.1	3.4
19980228	5.0	112.8	71.2	3.8	4.3	13.6	3.0
19980301	5.0	106.8	70.0	3.3	3.8	12.2	3.1
19980302	5.2	128.4	67.6	4.7	4.3	11.9	4.0
19980303	5.3	132.0	64.5	5.5	4.5	12.0	3.7
19980304	5.1	114.9	63.6	6.1	5.6	11.2	3.2
19980305	4.9	104.9	61.3	5.5	5.2	10.6	2.8
19980306	4.6	92.1	56.4	4.8	4.3	9.8	2.4
19980307	4.5	83.1	53.3	4.2	3.6	9.1	2.2
19980308	5.8	85.5	50.7	5.7	3.8	9.1	4.5
19980309	10.1	133.5	165.5	43.2	39.6	25.1	13.5
19980310	9.6	281.8	220.9	25.4	27.3	45.8	11.2
19980311	6.5	258.5	175.2	9.0	11.0	32.5	5.8
19980312	5.8	182.4	141.4	5.8	8.5	18.7	4.7
19980313	5.3	135.8	98.5	4.6	5.7	13.0	3.6
19980314	5.3	106.0	72.5	3.7	4.7	11.2	3.0
19980315	5.1	79.5	65.6	3.1	3.8	9.8	2.5
19980316	4.8	70.3	57.2	2.9	3.3	8.7	2.2
19980317	4.8	67.0	54.6	3.0	3.1	8.2	2.0
19980318	6.2	83.9	67.6	11.6	14.2	11.0	5.2
19980319	10.5	138.5	171.5	52.0	62.1	30.5	13.8
19980320	11.7	202.0	211.6	38.5	41.1	46.6	14.6
19980321	9.1	211.2	314.8	25.0	27.7	42.8	9.1
19980322	7.6	170.4	279.0	15.2	16.4	31.0	5.9
19980323	7.1	147.2	216.5	13.0	14.1	22.7	5.6
19980324	6.9	136.1	150.7	14.1	13.3	19.5	5.4
19980325	6.7	129.4	115.6	21.9	21.8	20.4	5.9
19980326	11.4	167.9	102.4	28.1	31.0	32.0	14.1
19980327	14.2	362.6	132.6	15.8	16.4	48.0	17.6
19980328	10.7	528.5	217.2	11.9	11.4	43.4	11.0
19980329	10.4	494.1	266.0	18.5	20.1	40.6	10.2
19980330	8.6	339.0	231.7	9.2	10.1	33.2	7.4
19980331	7.5	256.0	183.5	6.5	6.7	23.7	5.5
19980401	7.1	167.8	131.6	7.0	6.5	18.6	4.5
19980402	7.3	131.8	98.4	7.9	7.9	17.6	3.9
19980403	7.0	130.5	86.6	8.6	8.2	17.5	3.6
19980404	6.5	126.3	85.8	6.3	6.4	15.9	3.2
19980405	6.1	113.7	81.4	5.0	4.8	13.7	2.8
19980406	5.8	93.9	74.0	4.3	3.9	11.6	2.4
19980407	5.6	82.7	62.7	4.3	3.2	10.3	2.1
19980408	5.5	72.9	51.1	3.9	2.7	9.4	1.9
19980409	5.9	68.8	56.5	3.8	2.6	9.1	1.8
19980410	6.2	62.3	89.5	4.2	2.9	10.4	1.9
19980411	5.7	55.9	56.3	3.6	2.7	9.3	1.8
19980412	5.3	50.3	46.2	3.3	2.2	8.3	1.7
19980413	5.1	48.0	42.7	3.0	2.0	7.6	1.5

Date	Port Dover Lynn River	Port Maitland Grand River	Thames River	Port Bruce Catfish Creek	Port Stanley Kettle Creek	Port Burwell Big Otter Creek	Nanticoke Creek
19980414	5.7	49.0	42.9	3.9	2.2	7.8	1.6
19980415	6.0	56.2	39.0	5.8	4.0	9.6	1.9
19980416	6.9	63.9	46.4	7.4	4.7	10.1	5.8
19980417	7.4	98.1	62.1	17.8	14.9	16.1	5.6
19980418	6.2	109.5	65.8	9.1	8.8	14.8	3.5
19980419	6.4	110.1	71.9	6.4	5.6	12.6	3.6
19980420	8.8	120.5	72.0	11.4	8.9	18.1	8.5
19980421	7.5	[redacted]	69.2	7.9	7.8	18.7	5.3
19980422	[redacted]	90.3	58.9	5.9	5.1	14.7	[redacted]
19980423	5.5	76.4	[redacted]	4.9	3.6	11.4	3.3
19980424	5.4	68.2	43.7	4.1	2.9	9.6	2.9
19980425	5.1	58.5	39.7	3.4	2.3	8.3	2.4
19980426	4.8	51.3	38.4	2.9	1.9	7.4	2.0
19980427	4.2	47.4	38.7	2.5	1.7	6.9	1.6
19980428	4.5	44.9	34.6	[redacted]	[redacted]	6.4	1.3
19980429	4.4	42.6	32.8	1.9	1.3	[redacted]	1.2
19980430	4.3	41.6	32.1	1.9	1.3	6.0	1.1
19980501	4.3	41.0	32.0	2.0	1.4	6.1	1.1
19980502	4.6	41.2	40.9	2.5	1.8	7.4	1.1
19980503	4.5	41.2	84.6	2.2	1.8	7.0	1.2
19980504	4.3	40.9	50.6	2.0	1.4	6.5	1.2
19980505	4.2	39.8	39.9	1.8	1.3	6.2	1.2
19980506	4.1	38.9	35.2	1.7	1.3	5.9	1.2
19980507	4.0	38.0	32.4	1.8	1.0	5.7	1.2
19980508	4.0	37.1	30.3	1.7	1.0	5.5	1.2
19980509	3.9	36.3	29.3	1.4	1.0	5.4	1.2
19980510	4.0	36.1	27.7	1.3	1.0	5.2	1.2
19980511	5.1	44.2	26.7	1.5	1.0	5.7	1.4
19980512	4.8	50.1	26.7	1.6	1.0	6.0	1.7
19980513	4.2	50.6	27.5	1.4	1.0	5.7	1.7
19980514	3.9	47.9	20.4	1.3	0.9	5.4	1.6
19980515	3.7	44.1	19.5	1.2	0.7	5.1	1.4
19980516	3.5	39.5	17.0	1.1	0.6	4.9	1.2
19980517	3.4	36.0	18.6	1.0	0.7	4.7	1.0
19980518	3.3	33.0	17.9	0.9	0.5	4.5	0.9
19980519	3.1	31.3	17.4	0.9	0.5	4.4	0.8
19980520	3.1	30.5	16.9	0.9	0.4	4.3	0.7
19980521	3.0	29.0	16.3	0.8	0.3	4.1	0.6
19980522	3.0	28.3	15.4	0.7	0.2	4.0	0.5
19980523	2.9	27.8	15.0	0.7	0.2	3.9	0.5
19980524	2.9	27.2	14.7	0.7	0.3	3.8	0.5
19980525	3.0	28.5	14.7	0.8	0.4	3.9	0.5
19980526	3.1	32.5	14.7	0.7	0.4	4.1	0.5
19980527	2.9	29.7	15.0	0.7	0.4	4.0	0.5
19980528	2.8	28.0	14.2	0.6	0.3	3.8	0.5
19980529	2.8	26.8	13.4	0.6	0.4	3.7	0.5
19980530	2.6	25.9	13.1	0.5	0.3	3.6	0.4
19980531	2.7	25.8	14.9	0.5	0.3	3.5	0.5
19980601	2.8	26.5	13.1	0.6	0.3	3.8	0.4
19980602	2.8	25.5	12.8	0.5	0.3	3.6	0.4
19980603	2.6	26.2	12.2	0.5	0.3	3.5	0.4
19980604	2.5	25.3	11.8	0.5	0.2	3.3	0.4
19980605	2.4	25.4	12.2	0.5	0.2	3.2	0.4
19980606	2.4	24.9	12.3	0.4	0.2	3.1	0.3

Date	Port Dover Lynn River	Port Maitland Grand River	Thames River	Port Bruce Catfish Creek	Port Stanley Kettle Creek	Port Burwell Big Otter Creek	Nanticoke Creek
19980607	2.4	25.0	11.8	0.4	0.3	3.1	0.3
19980608	2.4	24.9	11.5	0.4	0.2	3.1	0.3
19980609	2.4	24.5	11.1	0.4	0.2	3.1	0.3
19980610	2.4	24.0	11.2	0.4	0.2	3.1	0.3
19980611	2.5	24.4	11.3	0.4	0.2	3.1	0.3
19980612	3.2	30.9	11.9	0.6	0.4	3.8	0.3
19980613	3.4	33.7	12.7	0.5	0.3	3.9	0.4
19980614	3.0	31.9	13.1	0.5	0.3	4.9	0.4
19980615	2.8	28.6	11.4	0.5	0.2	4.6	0.4
19980616	2.7	32.6	10.6	0.4	0.3	4.1	0.4
19980617	2.6	46.7	11.1	0.4	5.5	3.8	0.4
19980618	2.4	35.7	11.7	0.4	1.5	3.6	0.3
19980619	2.4	31.7	12.2	0.4	0.7	3.5	0.3
19980620	2.4	29.9	13.5	0.4	0.5	3.4	0.3
19980621	2.3	26.9	12.8	0.3	0.4	3.2	0.3
19980622	2.3	25.4	11.3	0.3	0.2	3.1	0.3
19980623	2.2	25.3	10.6	0.5	1.5	3.3	0.3
19980624	2.2	29.3	12.3	0.7	0.9	3.4	0.2
19980625	2.1	25.8	15.6	0.4	0.5	3.3	0.2
19980626	2.0	26.9	11.0	0.3	0.4	3.2	0.2
19980627	2.0	26.7	9.5	0.3	0.3	3.1	0.2
19980628	2.0	25.7	9.5	0.3	0.3	2.9	0.2
19980629	2.0	25.4	9.9	0.3	0.2	2.8	0.2
19980630	2.2	32.0	11.3	0.5	0.3	3.0	0.2
19980701	2.1	38.7	12.1	0.4	0.3	3.1	0.2
19980702	1.9	29.1	13.2	0.3	0.2	2.7	0.2
19980703	1.8	26.6	11.4	0.3	0.2	2.5	0.2
19980704	3.0	27.7	14.8	1.3	2.1	3.3	0.2
19980705	2.8	29.2	26.6	1.9	3.8	6.1	0.9
19980706	2.4	25.6	26.8	1.1	1.3	4.3	0.8
19980707	3.0	29.8	20.2	2.2	8.0	4.2	0.6
19980708	5.6	35.2	52.1	1.4	3.9	4.8	1.2
19980709	4.3	34.6	46.0	0.9	1.6	4.4	1.8
19980710	3.4	31.3	25.5	0.6	0.8	3.7	1.0
19980711	3.1	28.1	21.5	0.5	0.5	3.4	0.7
19980712	3.0	25.1	18.2	0.4	0.3	3.1	0.5
19980713	2.9	23.8	15.2	0.3	0.3	2.9	0.4
19980714	2.7	22.8	14.2	0.3	0.2	2.7	0.4
19980715	2.6	22.2	13.1	0.3	0.2	2.4	0.3
19980716	2.5	21.9	11.0	0.3	0.6	2.2	0.3
19980717	2.6	22.8	10.5	0.4	0.8	2.2	0.3
19980718	2.5	25.5	13.0	0.3	0.5	2.1	0.4
19980719	2.6	21.8	12.2	0.3	0.4	2.0	0.3
19980720	2.5	21.5	10.1	0.3	0.3	2.3	0.3
19980721	3.1	21.5	9.8	0.3	0.4	2.5	0.3
19980722	2.6	21.5	10.4	0.9	3.7	3.1	0.4
19980723	5.2	20.8	14.9	8.7	27.1	5.3	5.1
19980724	3.1	20.0	13.9	2.0	3.9	3.7	0.8
19980725	2.6	19.6	11.3	0.9	1.5	3.0	0.5
19980726	2.4	19.8	10.4	0.6	1.0	2.7	0.4
19980727	2.2	19.1	9.5	0.4	0.6	2.6	0.3
19980728	2.2	19.6	8.7	0.3	0.4	2.4	0.3
19980729	2.0	20.1	8.4	0.3	0.4	2.4	0.2
19980730	2.0	19.2	8.1	0.3	0.3	2.2	0.2

Date	Port Dover Lynn River	Port Maitland Grand River	Thames River	Port Bruce Catfish Creek	Port Stanley Kettle Creek	Port Burwell Big Otter Creek	Nanticoke Creek
19980731	2.0	19.6	8.0	0.2	0.3	2.0	0.2
19980801	1.9	19.3	7.9	0.2	0.3	2.0	0.2
19980802	1.9	19.0	7.6	0.2	0.2	1.9	0.1
19980803	1.8	18.6	7.3	0.2	0.2	1.8	0.1
19980804	1.9	19.1	7.1	0.1	0.2	1.8	0.1
19980805	1.8	19.0	[redacted]	0.2	0.2	1.9	0.1
19980806	2.1	20.8	8.5	0.3	0.6	2.4	0.1
19980807	2.1	29.7	11.6	0.5	1.0	3.0	0.1
19980808	2.0	29.1	16.9	0.3	0.7	2.8	0.1
19980809	1.9	24.6	14.0	0.3	0.4	2.6	0.1
19980810	2.0	23.1	12.3	0.2	0.3	2.9	0.2
19980811	2.0	22.9	12.4	0.2	[redacted]	2.8	0.2
19980812	2.0	21.7	13.0	0.2	0.3	[redacted]	0.2
19980813	1.9	21.4	15.6	[redacted]	0.2	2.5	0.1
19980814	1.8	19.9	15.2	0.2	0.2	2.3	0.1
19980815	1.8	19.9	15.6	0.2	0.2	2.2	0.1
19980816	1.8	19.7	20.8	0.2	0.2	2.0	0.1
19980817	1.7	18.1	11.0	0.2	0.3	1.8	0.1
19980818	2.0	19.9	12.0	0.3	0.8	1.9	0.1
19980819	1.8	19.3	12.8	0.2	0.6	2.1	0.1
19980820	1.8	18.5	13.5	0.2	0.3	1.9	0.1
19980821	1.8	18.2	10.3	0.1	0.3	1.8	0.1
19980822	1.8	20.7	10.1	0.1	0.2	2.2	0.1
19980823	1.9	19.3	9.6	0.2	0.2	2.0	0.1
19980824	1.8	19.5	8.4	0.2	0.1	2.0	0.1
19980825	[redacted]	22.7	8.0	0.1	0.2	2.1	0.1
19980826	1.8	20.8	8.0	0.2	0.2	2.0	[redacted]
19980827	1.8	[redacted]	7.6	0.1	0.2	1.8	0.1
19980828	1.7	17.2	7.7	0.1	0.1	1.7	0.1
19980829	1.7	17.8	8.4	0.1	0.3	1.8	0.1
19980830	1.7	17.3	8.7	0.2	0.2	2.2	0.1
19980831	1.8	17.1	8.4	0.2	0.2	1.9	0.0
19980901	1.8	16.6	7.8	0.1	0.2	1.8	0.0
19980902	1.9	16.8	7.6	0.1	0.1	1.9	0.0
19980903	1.9	17.6	7.4	0.1	0.2	2.0	0.0
19980904	1.8	17.6	7.4	0.1	0.2	2.0	0.0
19980905	1.8	16.8	7.3	0.1	0.2	1.9	0.0
19980906	1.7	16.9	7.3	0.1	0.1	1.9	0.0
19980907	2.1	18.3	7.3	0.2	0.3	2.2	0.1
19980908	1.9	19.1	8.1	0.3	0.2	2.3	0.1
19980909	1.9	18.4	10.2	0.1	0.2	2.2	0.1
19980910	1.9	17.9	8.6	0.1	0.1	2.1	0.1
19980911	1.9	17.5	7.8	0.1	0.1	2.1	0.2
19980912	1.8	17.5	7.5	0.1	0.2	2.0	0.2
19980913	1.8	17.4	7.3	0.1	0.2	2.0	0.2
19980914	1.9	17.0	7.7	0.1	0.1	2.0	0.2
19980915	2.0	17.9	8.3	0.1	0.2	2.1	0.2
19980916	1.9	18.1	8.6	0.2	0.3	2.3	0.2
19980917	1.9	17.6	8.9	0.2	0.2	2.2	0.2
19980918	1.9	17.3	8.5	0.1	0.2	2.1	0.2
19980919	1.8	17.9	7.7	0.1	0.2	2.0	0.2
19980920	1.9	17.9	7.3	0.1	0.2	2.1	0.2
19980921	1.9	17.6	7.3	0.1	0.1	2.1	0.2
19980922	1.8	17.2	7.4	0.1	0.1	2.1	0.2

Date	Port Dover Lynn River	Port Maitland Grand River	Thames River	Port Bruce Catfish Creek	Port Stanley Kettle Creek	Port Burwell Big Otter Creek	Nanticoke Creek
19980923	1.8	17.6	7.3	0.1	0.1	1.9	0.2
19980924	1.8	17.9	7.2	0.1	0.1	1.9	0.2
19980925	1.8	18.3	7.2	0.1	0.1	2.0	0.2
19980926	1.8	18.7	7.3	0.1	0.1	2.0	0.2
19980927	2.8	21.9	7.5	0.1	0.3	2.4	0.2
19980928	2.3	23.1	8.0	0.2	0.2	2.8	0.2
19980929	1.9	18.1	9.0	0.1	0.2	2.3	0.2
19980930	1.9	17.2	9.3	0.1	0.2	2.2	0.2
19981001	2.2	17.1	8.8	0.1	0.2	2.2	0.2
19981002	1.9	21.2	8.6	0.1	0.2	2.2	0.2
19981003	1.9	19.1	8.6	0.1	0.2	2.2	0.2
19981004	1.9	18.4	7.9	0.1	0.2	2.2	0.2
19981005	1.8	17.8	7.7	0.1	0.2	2.2	0.2
19981006	1.9	17.8	7.5	0.1	0.1	2.3	0.2
19981007	2.5	18.4	7.7	0.2	0.3	2.5	0.3
19981008	2.4	21.8	8.3	0.5	0.3	3.0	0.3
19981009	2.1	19.3	9.9	0.3	0.2	2.8	0.2
19981010	2.0	17.7	10.7	0.2	0.2	2.5	0.1
19981011	1.9	18.1	8.8	0.1	0.2	2.5	0.1
19981012	2.0	16.8	9.0	0.1	0.2	2.5	0.1
19981013	2.0	16.3	9.5	0.2	0.2	2.5	0.1
19981014	2.0	16.5	[redacted]	0.3	0.2	2.6	0.0
19981015	2.0	17.2	9.6	0.4	0.2	2.6	0.0
19981016	2.0	16.7	10.7	0.3	0.2	2.6	0.0
19981017	2.0	16.4	10.5	0.2	0.2	2.6	0.1
19981018	2.0	16.0	9.6	0.2	0.2	2.6	0.1
19981019	2.0	15.6	8.9	0.3	[redacted]	2.6	0.1
19981020	2.0	16.5	8.3	0.3	0.2	2.5	0.0
19981021	2.1	15.4	8.2	0.3	0.2	2.5	0.0
19981022	2.0	15.6	8.1	[redacted]	0.1	2.6	0.0
19981023	2.1	16.0	8.3	0.3	0.2	2.6	0.0
19981024	2.1	15.6	8.9	0.3	0.2	2.7	0.1
19981025	2.0	15.3	9.9	0.3	0.2	2.7	0.1
19981026	2.0	15.3	10.1	0.3	0.2	2.7	0.1
19981027	2.0	[redacted]	9.9	0.3	0.1	2.7	0.1
19981028	[redacted]	16.0	9.7	0.4	0.2	2.8	0.1
19981029	2.0	16.2	9.6	0.4	0.2	2.7	[redacted]
19981030	2.0	16.5	9.0	0.4	0.2	2.7	0.1
19981031	2.0	15.9	8.6	0.4	0.2	2.6	0.1
19981101	2.0	16.4	8.8	0.4	0.2	2.7	0.1
19981102	2.0	15.7	9.1	0.4	0.2	2.7	0.1
19981103	2.0	15.8	9.0	0.4	0.1	2.7	0.1
19981104	2.1	16.1	15.6	0.4	0.2	2.7	0.1
19981105	2.3	15.7	18.1	0.4	0.2	2.6	0.1
19981106	2.2	15.7	10.7	0.4	0.2	2.6	0.1
19981107	2.1	16.1	10.3	0.4	0.2	2.7	0.1
19981108	2.1	15.5	10.0	0.4	0.2	2.7	0.1
19981109	2.1	16.7	9.6	0.4	0.2	2.8	0.2
19981110	2.7	18.0	9.6	0.6	0.7	3.0	0.2
19981111	2.6	29.1	10.3	1.1	0.8	[redacted]	0.3
19981112	2.5	22.6	14.9	0.6	0.5	3.5	0.2
19981113	2.1	19.6	15.1	0.5	0.4	3.1	0.3
19981114	2.0	18.7	11.9	0.4	0.3	3.0	0.3
19981115	2.0	18.3	10.7	0.4	0.3	2.9	0.3

Date	Port Dover Lynn River	Port Maitland Grand River	Thames River	Port Bruce Catfish Creek	Port Stanley Kettle Creek	Port Burwell Big Otter Creek	Nanticoke Creek
19981116	2.0	18.7	10.1	0.4	0.3	2.9	0.2
19981117	2.2	22.3	9.8	1.2	0.3	3.0	0.2
19981118	2.0	22.0	9.9	1.1	0.2	2.9	0.2
19981119	2.0	19.4	9.6	1.0	0.2	2.9	0.2
19981120	2.0	18.5	9.1	0.9	0.2	2.9	0.2
19981121	2.0	18.0	9.2	0.8	0.2	2.8	0.2
19981122	2.0	17.5	9.2	0.6	0.3	2.8	0.2
19981123	2.0	17.2	9.5	0.4	0.4	2.8	0.2
19981124	1.9	16.9	9.5	0.3	0.4	2.8	0.2
19981125	2.0	16.9	9.3	0.2	0.4	2.8	0.2
19981126	2.6	19.4	9.9	0.3	0.6	3.1	0.3
19981127	2.2	21.2	10.8	0.3	0.4	3.2	0.3
19981128	2.0	18.8	12.1	0.3	0.3	2.9	0.3
19981129	2.0	18.1	10.5	0.2	0.2	2.8	0.3
19981130	2.2	17.7	9.9	0.3	0.2	2.8	0.3
19981201	2.5	20.8	9.6	0.3	0.2	3.0	0.3
19981202	2.1	21.4	10.1	0.3	0.3	3.1	0.3
19981203	2.0	18.9	11.5	0.3	0.3	2.9	0.3
19981204	2.0	18.2	10.5	0.3	0.3	2.8	0.3
19981205	2.2	18.8	10.5	0.3	0.3	2.8	0.3
19981206	2.0	20.3	10.1	0.3	0.4	2.8	0.3
19981207	2.2	41.5	11.0	0.3	0.5	2.9	0.3
19981208	2.0	33.4	12.0	0.3	0.4	2.9	0.3
19981209	1.9	28.5	13.1	0.3	0.4	2.7	0.3
19981210	1.9	25.2	11.2	0.3	0.3	2.7	0.3
19981211	1.9	22.7	11.0	0.3	0.3	2.7	0.3
19981212	1.9	21.2	12.7	0.3	0.3	2.6	0.3
19981213	1.9	20.1	12.7	0.2	0.3	2.6	0.3
19981214	1.8	19.0	12.4	0.2	0.3	2.6	0.3
19981215	1.8	18.5	12.2	0.2	0.3	2.6	0.2
19981216	1.8	18.1	12.2	0.2	0.2	2.6	0.2
19981217	1.8	18.1	12.1	0.3	0.3	2.6	0.3
19981218	1.8	18.1	10.5	0.3	0.3	2.6	0.3
19981219	2.1	18.5	10.5	0.3	0.6	2.9	0.3
19981220	1.9	19.6	10.7	0.5	0.6	3.4	0.3
19981221	2.5	20.0	14.9	0.4	0.9	3.3	0.3
19981222	2.6	27.0	14.2	0.9	1.4	3.2	0.6
19981223	2.0	19.2	16.9	0.6	1.1	3.3	0.5
19981224	1.9	16.3	15.5	0.4	0.7	5.6	0.4
19981225	1.8	23.3	14.5	0.3	0.5	5.2	0.4
19981226	1.8	24.5	13.7	0.3	0.3	4.8	0.4
19981227	1.7	21.5	13.0	0.3	0.3	4.4	0.3
19981228	1.8	20.4	12.2	0.3	0.3	4.1	0.3
19981229	1.8	20.0	11.9	0.3	0.3	3.8	0.3
19981230	1.7	20.3	11.4	0.3	0.3	3.6	0.3
19981231	1.7	21.5	11.1	0.3	0.3	3.4	0.3
Min	1.7	15.3	7.1	0.1	0.1	1.7	0.0
Max	15.9	528.5	486.2	89.7	92.7	71.4	25.9

Appendix B: Metals in sediment collected from Lake Erie harbours and embayments, 1998

Station Description	Station Number		Date YYYYMMDD	Sample Number	Sample Depth	Barium ug/g	Beryllium ug/g	RMK	Calcium ug/g	Cobalt ug/g	RMK	Magnesium ug/g	RMK	Molybdenum ug/g	RMK	Strontium ug/g	Titanium ug/g	RMK	Vanadium ug/g
Port Stanley-Lake stn.	1	1356	19980811	GL878769	10.8	74	0.5	<=W	120000	6.5		14000		0.5	<=W	170	200		27
Port Stanley-embayment	1	1355	19980811	GL878770	2	18	0.5	<=W	72000	2.6		14000		0.5	<=W	95	390		16
	1	1355	19980811	GL878771	2	17	0.5	<=W	72000	2.9		14000		0.5	<=W	94	370		17
	1	1355	19980811	GL878772	2	18	0.5	<=W	72000	3		14000		0.5	<=W	96	420		17
Port Stanley-Harbour	17	58	19980811	GL878773	7.1	53	0.5	<=W	87000	5.9		18000		0.5	<=W	120	290		25
	17	58	19980811	GL878774	7.1	45	0.5	<=W	86000	5.2		18000		0.5	<=W	120	270		20
	17	58	19980811	GL878775	7	53	0.5	<=W	89000	6.3		18000		0.5	<=W	130	370		27
Port Stanley-Harbour at storm sewer	17	57	19980811	GL878776	2.1	38	0.5	<=W	84000	4.9		17000		0.5	<=W	110	250		19
	17	57	19980811	GL878777	2.1	41	0.5	<=W	83000	5.1		16000		0.5	<=W	110	330		22
	17	57	19980811	GL878778	2.1	43	0.5	<=W	83000	5.1		17000		0.5	<=W	110	340		22
Port Stanley-Kettle Creek	15	67	19980811	GL878779	6.1	93	0.7	<T	77000	9.6		15000		0.5	<=W	120	280		36
	15	67	19980811	GL878780	6.1	98	0.8	<T	82000	9.8		15000		0.5	<=W	130	350		39
split	15	67	19980811	GL878781	6.1	98	0.8	<T	81000	9.2		15000		0.5	<=W	120	360		39
split	15	67	19980811	GL878782	6.1	96	0.8	<T	78000	9.1		15000		0.5	<=W	120	310		38
Port Stanley-Kettle Creek (upstream)	15	66	19980811	GL878783	2.5	130	1	<T	73000	11		14000		0.5	<=W	120	290		43
	15	66	19980811	GL878784	2.5	84	0.7	<T	76000	8.2		13000		0.5	<=W	110	290		33
	15	66	19980811	GL878785	2.5	120	0.9	<T	77000	10		15000		0.5	<=W	120	400		45
Port Burwell-Lake stn.	1	1350	19980812	GL879088	2.5	14	0.5	<=W	77000	1.8	<T	15000		0.5	<=W	100	440		17
	1	1350	19980812	GL879089	2.5	14	0.5	<=W	76000	2.4	<T	15000		0.5	<=W	99	470		16
	1	1350	19980812	GL879090	2.5	14	0.5	<=W	76000	2.1	<T	15000		0.5	<=W	100	460		17
Port Burwell-Harbour	17	52	19980812	GL879091	1.9	15	0.5	<=W	54000	1.9	<T	12000		0.5	<=W	71	530		19
	17	52	19980812	GL879092	1.9	15	0.5	<=W	54000	1.7	<T	12000		0.5	<=W	71	500		17
	17	52	19980812	GL879093	1.9	17	0.5	<=W	55000	2.1	<T	12000		0.5	<=W	72	400		17
Port Burwell-Harbour embayment	17	51	19980812	GL879094	1.7	14	0.5	<=W	66000	2.2	<T	15000		0.5	<=W	86	500		18
	17	51	19980812	GL879095	1.7	15	0.5	<=W	68000	2.1	<T	16000		0.6	<T	90	660		19
	17	51	19980812	GL879096	1.7	16	0.5	<=W	67000	2.3	<T	16000		0.5	<=W	90	670		20
Port Burwell-Big Otter Creek	15	73	19980812	GL879097	0.9	18	0.5	<=W	45000	2.1	<T	7900		0.5	<=W	63	460		14
	15	73	19980812	GL879098	0.9	21	0.5	<=W	47000	2.4	<T	8700		0.5	<=W	68	500		17
	15	73	19980812	GL879099	0.8	22	0.5	<=W	50000	3.1		9000		0.5	<=W	70	350		15
Port Burwell-Big Otter Creek	15	71	19980812	GL879100	3.8	55	0.5	<=W	70000	5.6		13000		0.5	<=W	99	380		26
(south of bridge)	15	71	19980812	GL879101	3.8	59	0.5	<=W	72000	5.7		13000		0.5	<=W	100	420		27
	15	71	19980812	GL879102	3.8	60	0.5	<=W	73000	5.5		13000		0.5	<=W	100	380		27
Port Burwell-Big Otter Creek	15	61	19980812	GL879103	1.8	43	0.5	<=W	62000	4.7		11000		0.5	<=W	88	320		21
	15	61	19980812	GL879104	1.8	52	0.5	<=W	68000	5		12000		0.5	<=W	96	340		23
split	15	61	19980812	GL879105	1.6	66	0.5	<=W	75000	5.8		13000		0.5	<=W	110	400		29
split	15	61	19980812	GL879106	1.6	67	0.5	<=W	75000	6.4		13000		0.5	<=W	110	370		28
Port Bruce-Lake stn.	1	1354	19980813	GL879116	7	25	0.5	<=W	82000	3.2		16000		0.5	<=W	110	410		20
	1	1354	19980813	GL879117	7	23	0.5	<=W	80000	3.1		16000		0.5	<=W	110	370		19
	1	1354	19980813	GL879118	7	23	0.5	<=W	80000	3.4		16000		0.5	<=W	110	380		19
Port Bruce-embayment	1	1352	19980813	GL879119	2.1	11	0.5	<=W	67000	2.1	<T	9800		0.5	<=W	93	670		26
	1	1352	19980813	GL879120	2.2	12	0.5	<=W	63000	1.8	<T	8700		0.5	<=W	88	490		17
	1	1352	19980813	GL879121	2.1	10	0.5	<=W	65000	2.4	<T	10000		0.5	<=W	88	850		43
Port Bruce-outside harbour	1	1353	19980813	GL879122	3.4	14	0.5	<=W	74000	1.8	<T	8300		0.5	<=W	100	310		14
	1	1353	19980813	GL879123	3.4	14	0.5	<=W	72000	1.7	<T	8300		0.5	<=W	100	400		16
	1	1353	19980813	GL879124	3.4	13	0.5	<=W	69000	2.5		7800		0.5	<=W	97	370		16
Port Bruce-Harbour	17	56	19980813	GL879125	2	12	0.5	<=W	64000	2.4	<T	10000		0.5	<=W	83	370		12
	17	56	19980813	GL879126	2	13	0.5	<=W	66000	1.7	<T	11000		0.5	<=W	84	370		13
	17	56	19980813	GL879127	2	12	0.5	<=W	66000	2.5		10000		0.5	<=W	86	410		15
Port Bruce-Harbour	17	55	19980813	GL879128	1.5	10	0.5	<=W	61000	1.6	<T	12000		0.5	<=W	65	420		13
	17	55	19980813	GL879129	1.4	10	0.5	<=W	61000	2.2	<T	12000		0.5	<=W	65	570		16
	17	55	19980813	GL879130	1.5	10	0.5	<=W	61000	2.2	<T	12000		0.5	<=W	65	440		14
Port Bruce-Catfish Creek	15	65	19980813	GL879131	1.5	67	0.5	<=W	76000	6.6		16000		0.5	<=W	99	420		31
	15	65	19980813	GL879132	2	100	0.8	<T	76000	9.5		16000		0.5	<=W	120	410		41
split	15	65	19980813	GL879133	2.7	88	0.7	<T	79000	7.9		15000		0.5	<=W	110	480		38
split	15	65	19980813	GL879134	2.7	92	0.7	<T	80000	7.9		15000		0.5	<=W	120	510		40

<W no measurable response

<T measurable trace amount, interpret with caution

<=> approximate value

Station Description	Station Number		Date YYYYMMDD	Sample Number	Sample Depth	Barium ug/g	Beryllium ug/g		Calcium ug/g	Cobalt ug/g		Magnesium ug/g	Molybdenum ug/g		Strontium ug/g	Titanium ug/g		Vanadium ug/g
Leamington-WPCP outfall	1	1363	19980819	GL879158	7.2	20	0.5	<=W	72000	3.2		18000	1	<T	78	390		21
	1	1363	19980819	GL879159	7.3	18	0.5	<=W	72000	3.3		18000	1.1	<T	78	350		20
	1	1363	19980819	GL879160	7.4	19	0.5	<=W	71000	3.2		18000	1.1	<T	77	340		20
Leamington-Harbour	17	60	19980819	GL879161	2.9	29	0.5	<=W	57000	3.6		13000	0.9	<T	68	270		23
	17	60	19980819	GL879162	2.9	33	0.5	<=W	56000	4.2		13000	1.4	<T	67	270		25
split	17	60	19980819	GL879163	3	32	0.5	<=W	54000	5.1		12000	1.8	<T	66	260		24
split	17	60	19980819	GL879164	3	32	0.5	<=W	54000	4.9		12000	1.5	<T	68	250		24
Leamington-Harbour (NW corner)	17	59	19980819	GL879165	1.7	10	0.5	<=W	51000	2.7		7900	0.8	<T	63	710		32
	17	59	19980819	GL879166	1.9	9	0.5	<=W	49000	2.1	<T	7500	0.5	<=W	62	730		31
	17	59	19980819	GL879167	1.8	9	0.5	<=W	49000	2.1	<T	7200	0.5	<=W	62	580		24
Leamington-Harbour entrance	17	61	19980819	GL879168	5.4	47	0.5	<=W	59000	6.8		15000	2.3	<T	77	200		27
	17	61	19980819	GL879169	5.4	43	0.5	<=W	60000	6.6		14000	2.1	<T	78	210		27
	17	61	19980819	GL879170	5.5	43	0.5	<=W	60000	6.1		14000	2.1	<T	78	220		26
Leamington offshore from marina	1	1357	19980819	GL879171	7.3	18	0.5	<=W	60000	3.4		12000	2.2	<T	70	380		22
	1	1357	19980819	GL879172	7.2	16	0.5	<=W	50000	4		11000	2.3	<T	58	360		21
	1	1357	19980819	GL879173	7.2	17	0.5	<=W	57000	4.1		13000	2.1	<T	61	470		31
Wheatly-east of harbour entrance	1	539	19980820	GL879174	2.9	16	0.5	<=W	70000	4.9		9400	3.1		81	350		27
	1	539	19980820	GL879175	3	19	0.5	<=W	68000	5.1		8500	3.6		81	380		27
	1	539	19980820	GL879176	2.8	22	0.5	<=W	70000	6		8500	4.7		85	310		30
Wheatly-south slip	17	94	19980820	GL879177	3.3	120	0.8	<T	46000	11		12000	3.4		86	80	<T	37
	17	94	19980820	GL879178	3.3	120	0.9	<T	55000	11		13000	3.2		100	160		43
	17	94	19980820	GL879179	3.3	110	0.9	<T	53000	10		13000	3.2		100	150		40
Wheatly-mid-harbour off MNR dock	17	93	19980820	GL879180	2.4	120	0.7	<T	48000	7.7		8100	2.3	<T	100	190		31
	17	93	19980820	GL879181	2.4	110	0.7	<T	44000	7.6		8100	2.9		97	190		32
split	17	93	19980820	GL879182	2.4	130	0.8	<T	41000	8.5		9100	3.1		97	160		35
split	17	93	19980820	GL879183	2.4	120	0.8	<T	40000	8.9		9100	3		88	130		33
Wheatly-middle slip	17	92	19980820	GL879184	1.9	160	1.1	<T	25000	12		11000	2.4	<T	77	100		47
	17	92	19980820	GL879185	1.9	150	1	<T	25000	11		11000	2.4	<T	75	80	<T	42
	17	92	19980820	GL879186	1.9	160	1.1	<T	25000	12		11000	3		80	130		48
Wheatly-north slip	17	91	19980820	GL879187	1.6	160	1.1	<T	22000	11		10000	2.7		73	110		47
	17	91	19980820	GL879188	1.6	160	1.1	<T	22000	12		11000	2.6		73	140		52
	17	91	19980820	GL879189	1.6	160	1.1	<T	23000	12		11000	2.9		78	120		51
Wheatly-south of Bridge	17	90	19980820	GL879190	2.4	63	0.5	<=W	66000	4		9800	1.9	<T	81	130		23
	17	90	19980820	GL879191	2.4	80	0.5	<=W	54000	6.2		8900	2.5		95	100		23
	17	90	19980820	GL879192	2.4	64	0.5	<=W	54000	5.3		8800	1.5	<T	80	120		19
Port Dover-Harbour	17	62	19980825	GL879231	3.5	20	0.5	<=W	54000	3.3		7800	0.5	<=W	77	470		17
	17	62	19980825	GL879232	3.5	47	0.5	<=W	61000	4.3		8800	0.5	<=W	94	350		20
	17	62	19980825	GL879233	3.5	38	0.5	<=W	63000	4.2		8600	0.5	<=W	92	290		15
Port Dover-Lynn River	15	70	19980825	GL879234	3.2	120	0.7	<T	62000	7.9		9500	0.5	<=W	110	400		35
	15	70	19980825	GL879235	3.2	140	0.8	<T	66000	8.9		10000	0.5	<=W	120	420		40
split	15	70	19980825	GL879236	3.2	120	0.7	<T	65000	8.4		9600	0.5	<=W	110	370		35
split	15	70	19980825	GL879237	3.2	130	0.8	<T	65000	9.1		10000	0.5	<=W	110	420		38
Port Dover-Lynn River	15	69	19980825	GL879238	2.1	73	0.5	<=W	70000	4.6		6800	0.5	<=W	99	330		21
	15	69	19980825	GL879239	2.1	57	0.5	<=W	44000	5.1		4200	0.5	<=W	69	370		21
	15	69	19980825	GL879240	2.1	86	0.5	<=W	81000	4.5		8600	0.5	<=W	100	330		21
Port dover-Black Creek	15	68	19980825	GL879241	2.8	150	0.9	<T	58000	10		9800	0.5	<=W	120	420		43
	15	68	19980825	GL879242	2.8	150	0.9	<T	58000	10		10000	0.5	<=W	120	450		44
	15	68	19980825	GL879243	2.8	150	0.9	<T	56000	9.8		10000	0.5	<=W	110	460		45
Port Dover-Lake stn.	1	1358	19980826	GL879254	5.2	22	0.5	<=W	49000	1.8	<T	9700	0.5	<=W	67	450		19
	1	1358	19980826	GL879255	5.2	19	0.5	<=W	50000	2.4	<T	11000	0.5	<=W	67	410		18
Nanticoke-Texaco Can. outfall	1	1362	19980826	GL879256	5.2	96	0.6	<T	99000	8.3		11000	0.5	<=W	180	400		31
Nanticoke-Esso outfall	1	1365	19980826	GL879257	6.6	37	0.5	<=W	72000	5.2		13000	0.5	<=W	110	450		24
	1	1365	19980826	GL879258	6.6	40	0.5	<=W	71000	4.7		13000	0.5	<=W	110	490		25
	1	1365	19980826	GL879259	6.6	44	0.5	<=W	70000	3.8		13000	0.5	<=W	110	560		27
Nanticoke Creek (mouth)	15	72	19980826	GL879260	2.2	60	0.5	<=W	42000	5.6		6300	0.5	<=W	86	380		26
	15	72	19980826	GL879261	2.2	41	0.5	<=W	39000	4.2		5100	0.5	<=W	74	440		23
split	15	72	19980826	GL879262	2.2	80	0.5	<=W	44000	6.9		7200	0.5	<=W	100	330		29
split	15	72	19980826	GL879263	2.2	66	0.6	<T	42000	6.4		6200	0.5	<=W	93	350		26

<W no measurable response
<T measurable trace amount, interpret with caution
<=> approximate value

Station Description	Station Number		Date YYYYMMDD	Sample Number	Sample Depth	Barium ug/g	Beryllium ug/g		Calcium ug/g	Cobalt ug/g		Magnesium ug/g	Molybdenum ug/g		Strontium ug/g	Titanium ug/g	Vanadium ug/g
Nanticoke-Stelco outfall	1	1359	19980826	GL879264	1.1	10	0.5	<=W	45000	4.1		9500	0.5	<=W	65	1300	74
(off Centre Creek)	1	1359	19980826	GL879265	1.1	10	0.5	<=W	45000	4.1		9400	0.5	<=W	65	1300	84
	1	1359	19980826	GL879266	1.1	11	0.5	<=W	44000	4.1		9300	0.5	<=W	64	1200	83
Port Maitland-Lake Erie	1	1351	19980827	GL879280	7.6	13	0.5	<=W	56000	1.3	<T	15000	0.5	<=W	69	830	27
	1	1351	19980827	GL879281	7.6	14	0.5	<=W	56000	1.1	<T	15000	0.5	<=W	72	710	22
	1	1351	19980827	GL879282	7.6	11	0.5	<=W	55000	1.6	<T	15000	0.5	<=W	69	710	22
Port Maitland-Harbour	17	54	19980827	GL879283	7.8	100	0.6	<T	75000	8.4		14000	0.5	<=W	190	370	38
	17	54	19980827	GL879284	7.8	96	0.6	<T	75000	7.7		14000	0.5	<=W	190	320	35
split	17	54	19980827	GL879285	7.8	100	0.7	<T	76000	8.1		14000	0.5	<=W	190	380	39
split	17	54	19980827	GL879286	7.8	100	0.7	<T	76000	8		14000	0.5	<=W	200	370	37
Port Maitland-Grand River	15	64	19980827	GL879287	4.7	57	0.5	<=W	66000	4.6		13000	0.5	<=W	140	270	20
	15	64	19980827	GL879288	4.2	58	0.5	<=W	66000	4.7		13000	0.5	<=W	140	270	20
	15	64	19980827	GL879289	4.3	56	0.5	<=W	65000	4.2		12000	0.5	<=W	140	240	20
Port Maitland-Grand River	15	63	19980827	GL879290	7.2	91	0.6	<T	94000	7.4		17000	0.5	<=W	250	350	32
	15	63	19980827	GL879291	7.1	92	0.6	<T	98000	7.5		16000	0.5	<=W	270	330	32
	15	63	19980827	GL879292	7	100	0.7	<T	88000	7.9		15000	0.5	<=W	250	320	34
Port Maitland-Grand River	15	62	19980827	GL879293	7	120	0.8	<T	83000	9.7		14000	0.5	<=W	260	290	39
	15	62	19980827	GL879294	7	120	0.8	<T	82000	9.8		14000	0.5	<=W	260	300	40
	15	62	19980827	GL879295	7	110	0.8	<T	82000	9.1		13000	0.5	<=W	260	240	37
Lake St. Clair-West of Thames River	1	231	19980805	GL878749	1.2	8	0.5	<=W	19000	2.6		6500	0.5	<=W	21	500	15
Lake St. Clair-West of Thames River	1	231	19980805	GL878750	1.2	8	0.5	<=W	19000	2.8		6500	0.5	<=W	21	370	12
Lake St. Clair-West of Thames River	1	231	19980805	GL878751	1.2	9	0.5	<=W	18000	2.7		6700	0.5	<=W	21	560	16
Lake St. Clair-Thames River	1	232	19980804	GL878745	2.2	10	0.5	<=W	34000	3.1		10000	0.6	<T	38	660	19
Lake St. Clair-Thames River	1	232	19980804	GL878746	2.2	10	0.5	<=W	36000	2.6		11000	0.5	<=W	37	360	19
Lake St. Clair-Thames River	1	232	19980804	GL878747	2.2	10	0.5	<=W	34000	2.8		10000	0.5	<=W	36	620	19
Lake St. Clair-Thames River	1	232	19980805	GL878748	2.2	9	0.5	<=W	34000	2.7		10000	0.6	<T	36	630	19
Lake St. Clair-North of Thames River	1	230	19980805	GL878752	1.9	16	0.5	<=W	66000	3.5		9600	1	<T	70	240	15
Lake St. Clair-North of Thames River	1	230	19980805	GL878753	1.9	14	0.5	<=W	70000	2.7		10000	0.5	<=W	73	270	14
Lake St. Clair-North of Thames River	1	230	19980805	GL878754	1.9	15	0.5	<=W	66000	3		10000	0.8	<T	70	230	13
Thames River-mouth	15	16	19980805	GL878755	5.7	130	1.1	<T	55000	12		12000	0.5	<=W	120	140	58
Thames River-mouth	15	16	19980805	GL878756	5.7	130	1.1	<T	56000	12		12000	0.5	<=W	120	130	57
Thames River-mouth	15	16	19980805	GL878757	5.7	130	1.1	<T	57000	12		12000	0.6	<T	120	160	56
Thames River (upstream)	15	15	19980805	GL878758	0.9	61	0.5	<=W	75000	6.4		16000	0.5	<=W	110	260	30
Thames River (upstream)	15	15	19980805	GL878759	0.9	55	0.5	<=W	76000	5.9		17000	1.1	<T	110	270	28
Thames River (upstream)	15	15	19980805	GL878760	0.9	59	0.5	<=W	72000	6.3		17000	1	<T	100	330	31

<W no measurable response
<T measurable trace amount, interpret with caution
<=> approximate value

Appendix C: Correlation matrix for water quality data, Lake Erie Harbour Water Quality Monitoring Survey, 1998 ($p<0.05$)

Port Stanley

	Conductivity	Chloride	Ammonia/	Nitrite	Nitrate	TIN	TKN	TON	TP	SS	Al	Cr	Fe
Conductivity	1.000												
Chloride	0.975	1.000											
Ammonia/	0.374	0.458	1.000										
Nitrite	0.628	0.701	0.749	1.000									
Nitrate	0.968	0.970	0.481	0.757	1.000								
TIN	0.965	0.970	0.503	0.768	1.000	1.000							
TKN	0.830	0.879	0.744	0.891	0.862	0.872	1.000						
TON	0.867	0.903	0.661	0.870	0.885	0.891	0.993	1.000					
TP	0.307	0.401	0.639	0.798	0.389	0.402	0.735	0.714	1.000				
SS	-0.090	-0.065	0.285	0.449	-0.050	-0.041	0.354	0.348	0.847	1.000			
Al	0.421	0.503	0.623	0.635	0.405	0.417	0.746	0.730	0.877	0.701	1.000		
Cr	-0.296	-0.202	0.412	0.429	-0.159	-0.145	0.185	0.139	0.678	0.753	0.390	1.000	
Fe	0.064	0.099	0.397	0.492	0.068	0.078	0.484	0.475	0.886	0.950	0.866	0.625	1.000

Port Maitland

	Conductivity	Chloride	Ammonia/	Nitrite	Nitrate	TIN	TKN	TON	TP	SS	Al	Cr	Fe
Conductivity	1.000												
Chloride	0.933	1.000											
Ammonia/	0.598	0.749	1.000										
Nitrite	0.615	0.304	-0.068	1.000									
Nitrate	0.304	-0.039	-0.451	0.908	1.000								
TIN	0.382	0.040	-0.363	0.941	0.995	1.000							
TKN	0.957	0.851	0.649	0.683	0.350	0.435	1.000						
TON	0.921	0.733	0.389	0.854	0.602	0.670	0.954	1.000					
TP	0.878	0.676	0.414	0.856	0.601	0.672	0.949	0.985	1.000				
SS	0.560	0.238	-0.127	0.986	0.920	0.947	0.631	0.814	0.824	1.000			
Al	0.553	0.226	-0.135	0.991	0.938	0.965	0.628	0.814	0.825	0.986	1.000		
Cr	-0.319	-0.079	-0.157	-0.665	-0.546	-0.587	-0.534	-0.583	-0.673	-0.653	-0.698	1.000	
Fe	0.681	0.380	0.005	0.984	0.873	0.912	0.742	0.896	0.901	0.980	0.979	-0.682	1.000

Port Bruce

	Conductivity	Chloride	Ammonia/	Nitrite	Nitrate	TIN	TKN	TON	TP	SS	Al	Cr	Fe
Conductivity	1.000												
Chloride	0.909	1.000											
Ammonia/	0.496	0.421	1.000										
Nitrite	0.681	0.735	-0.131	1.000									
Nitrate	0.691	0.727	-0.237	0.944	1.000								
TIN	0.713	0.751	-0.206	0.947	0.999	1.000							
TKN	0.634	0.715	0.580	0.438	0.289	0.310	1.000						
TON	0.614	0.715	0.492	0.484	0.339	0.358	0.995	1.000					
TP	0.286	0.346	0.543	0.218	-0.049	-0.032	0.811	0.797	1.000				
SS	-0.147	-0.128	0.193	-0.014	-0.288	-0.284	0.183	0.171	0.696	1.000			
Al	0.011	0.073	0.218	0.043	-0.188	-0.182	0.267	0.258	0.612	0.796	1.000		
Cr	0.102	-0.134	0.465	-0.256	-0.284	-0.271	-0.129	-0.196	0.087	0.278	-0.142	1.000	
Fe	-0.118	-0.043	0.107	-0.031	-0.248	-0.247	0.128	0.123	0.515	0.797	0.987	-0.151	1.000

Port Burwell

	Conductivity	Chloride	Ammonia/	Nitrite	Nitrate	TIN	TKN	TON	TP	SS	Al	Cr	Fe
Conductivity	1.000												
Chloride	0.973	1.000											
Ammonia/	-0.414	-0.002	1.000										
Nitrite	-0.021	0.190	0.234	1.000									
Nitrate	0.980	0.822	-0.286	0.082	1.000								
TIN	0.980	0.823	-0.281	0.083	1.000	1.000							
TKN	0.448	0.601	-0.068	0.789	0.469	0.470	1.000						
TON	0.462	0.600	-0.112	0.775	0.480	0.481	0.999	1.000					
TP	-0.163	0.031	0.188	0.951	-0.090	-0.089	0.759	0.747	1.000				
SS	-0.371	-0.157	0.328	0.900	-0.302	-0.301	0.559	0.542	0.948	1.000			
Al	-0.331	-0.064	0.310	0.932	-0.234	-0.233	0.635	0.618	0.973	0.986	1.000		
Cr	0.550	0.571	0.086	0.587	0.546	0.548	0.691	0.684	0.516	0.433	0.447	1.000	
Fe	-0.371	-0.114	0.358	0.907	-0.285	-0.284	0.557	0.538	0.942	0.994	0.990	0.438	1.000

Thames River

	Conductivity	Chloride	Ammonia/	Nitrite	Nitrate	TIN	TKN	TON	TP	SS	Al	Cr	Fe
Conductivity	1.000												
Chloride	0.930	1.000											
Ammonia/	0.803	0.946	1.000										
Nitrite	0.794	0.873	0.773	1.000									
Nitrate	0.579	0.256	0.011	0.272	1.000								
TIN	0.624	0.309	0.068	0.316	0.998	1.000							
TKN	0.803	0.836	0.759	0.693	0.308	0.351	1.000						
TON	0.701	0.688	0.571	0.574	0.385	0.416	0.968	1.000					
TP	0.750	0.790	0.694	0.615	0.242	0.281	0.938	0.915	1.000				
SS	0.413	0.177	-0.075	0.192	0.732	0.726	0.184	0.262	0.321	1.000			
Al	0.612	0.302	0.053	0.279	0.954	0.955	0.355	0.427	0.374	0.858	1.000		
Cr	0.381	0.362	0.422	-0.070	0.016	0.040	0.369	0.302	0.488	0.200	0.176	1.000	
Fe	0.739	0.534	0.330	0.418	0.767	0.784	0.561	0.580	0.640	0.869	0.900	0.429	1.000

Nanticoke

	Conductivity	Chloride	Ammonia/	Nitrite	Nitrate	TIN	TKN	TON	TP	SS	Al	Cr	Fe
Conductivity	1.000												
Chloride	0.510	1.000											
Ammonia/	0.554	0.438	1.000										
Nitrite	0.922	0.272	0.362	1.000									
Nitrate	0.870	0.219	0.181	0.977	1.000								
TIN	0.880	0.230	0.206	0.982	1.000	1.000							
TKN	0.957	0.426	0.683	0.893	0.798	0.811	1.000						
TON	0.964	0.410	0.627	0.916	0.832	0.844	0.997	1.000					
TP	0.927	0.352	0.628	0.898	0.811	0.823	0.964	0.964	1.000				
SS	0.759	0.222	0.591	0.747	0.644	0.656	0.830	0.825	0.922	1.000			
Al	0.919	0.361	0.614	0.896	0.803	0.815	0.961	0.962	0.975	0.918	1.000		
Cr	0.624	0.488	0.385	0.630	0.596	0.603	0.606	0.607	0.624	0.544	0.603	1.000	
Fe	0.772	0.335	0.734	0.697	0.561	0.577	0.864	0.847	0.914	0.965	0.932	0.527	1.000

Port Dover

	Conductivity	Chloride	Ammonia/	Nitrite	Nitrate	TIN	TKN	TON	TP	SS	Al	Cr	Fe
Conductivity	1.000												
Chloride	0.921	1.000											
Ammonia/	0.662	0.673	1.000										
Nitrite	0.920	0.808	0.842	1.000									
Nitrate	0.956	0.784	0.551	0.903	1.000								
TIN	0.965	0.801	0.606	0.929	0.998	1.000							
TKN	0.645	0.532	0.618	0.714	0.624	0.645	1.000						
TON	0.481	0.338	0.293	0.482	0.506	0.506	0.933	1.000					
TP	0.647	0.496	0.642	0.757	0.654	0.675	0.966	0.881	1.000				
SS	0.056	-0.163	0.096	0.221	0.191	0.190	0.355	0.387	0.537	1.000			
Al	0.109	-0.155	0.085	0.269	0.281	0.275	0.357	0.395	0.506	0.931	1.000		
Cr	0.198	0.248	-0.077	0.053	0.193	0.178	-0.014	0.018	-0.070	-0.166	-0.146	1.000	
Fe	0.316	0.085	0.365	0.481	0.404	0.415	0.507	0.449	0.684	0.832	0.750	-0.474	1.000

Appendix D: Aluminum, iron and chromium concentrations (u g/L) in water collected from Lake Erie, 1998

Station Description	Station			Date	Field No.	Aluminum	Chromium	Iron
Port Maitland								
Port Maitland-Lake Erie	16	1	1351	19980421	GL878684	349 +/- 22	1.41 +/- 0.35	376 +/- 43
Port Maitland-Harbour	16	17	54	19980421	GL878685	485 +/- 50	1.74 +/- 0.54	621 +/- 91
	16	17	54	19980421	GL878686	498 +/- 81	0.86 +/- 0.54	621 +/- 90
Port Maitland-Grand River	16	15	64	19980421	GL878687	480 +/- 47	1.12 +/- 0.37	611 +/- 44
Port Maitland-Grand River	16	15	63	19980421	GL878688	521 +/- 37	0.77 +/- 0.36	589 +/- 47
Port Maitland-Grand River	16	15	62	19980421	GL878689	506 +/- 26	0.76 +/- 0.36	557 +/- 36
Port Maitland-Lake Erie	16	1	1351	19980827	GL879272	49 +/- 11	3.40 +/- 5	62 +/- 50
Port Maitland-Harbour	16	17	54	19980827	GL879273	173 +/- 13	0.59 +/- 5	277 +/- 53
Port Maitland-Grand River	16	15	64	19980827	GL879274	145 +/- 22	5.88 +/- 5.1	234 +/- 63
Port Maitland-Grand River	16	15	63	19980827	GL879275	169 +/- 14	6.45 +/- 5	268 +/- 54
	16	15	63	19980827	GL879276	172 +/- 13	2.28 +/- 5	318 +/- 62
Port Maitland-Grand River	16	15	62	19980827	GL879277	181 +/- 15	4.35 +/- 5	286 +/- 54
Port Maitland-Lake Erie	16	1	1351	19981027	GL879337	10 +/- 10	5.89 +/- 5	7 +/- 50
Port Maitland-Harbour	16	17	54	19981027	GL879338	40 +/- 12	6.60 +/- 5	33 +/- 50
Port Maitland-Grand River	16	15	64	19981027	GL879339	73 +/- 15	7.24 +/- 5	58 +/- 50
Port Maitland-Grand River	16	15	63	19981027	GL879340	93 +/- 12	8.52 +/- 5	137 +/- 51
Port Maitland-Grand River	16	15	62	19981027	GL879341	103 +/- 12	12.80 +/- 5.1	182 +/- 53
	16	15	62	19981027	GL879342	107 +/- 14	10.80 +/- 5.1	167 +/- 52
Port Maitland- (F-blank)	16	15	62	19980421	GL878690	3 +/- 1	0.07 +/- 0.37	6 +/- 23
Port Maitland- (F-blank)	16	15	62	19980827	GL879278	0 +/- 10	0.00 +/- 5	2 +/- 50
Port Maitland- (F-blank)	16	15	62	19980824	GL879279	1 +/- 10	0.01 +/- 5	11 +/- 50
Nanticoke								
Nanticoke-Ontario Hydro outfall	16	1	1362	19980422	GL878691	38 +/- 9	3.20 +/- 0.93	24 +/- 22
Nanticoke-Esso outfall	16	1	1365	19980422	GL878692	35 +/- 3	2.86 +/- 0.65	21 +/- 21
Nanticoke Creek	16	1	1361	19980422	GL878693	233 +/- 26	0.51 +/- 0.34	188 +/- 26
Nanticoke Creek (mouth)	16	15	72	19980422	GL878694	651 +/- 33	8.60 +/- 2.1	643 +/- 40
	16	15	72	19980422	GL878695	773 +/- 100	6.50 +/- 0.72	748 +/- 83
Nanticoke	16	1	1360	19980422	GL878696	157 +/- 14	3.81 +/- 0.55	108 +/- 26
Nanticoke-Stelco outfall	16	1	1359	19980422	GL878697	83 +/- 9	0.50 +/- 0.41	55 +/- 22
Nanticoke-Ontario Hydro outfall	16	1	1362	19980826	GL879246	28 +/- 10	0.28 +/- 5	54 +/- 50
	16	1	1362	19980826	GL879247	28 +/- 10	2.80 +/- 5	42 +/- 50
Nanticoke-Esso outfall	16	1	1365	19980826	GL879248	28 +/- 10	1.40 +/- 5	43 +/- 50
Nanticoke	16	1	1361	19980826	GL879249	160 +/- 13	3.40 +/- 5	291 +/- 56
Nanticoke Creek (mouth)	16	15	72	19980826	GL879250	397 +/- 56	4.21 +/- 5	626 +/- 66
Nanticoke	16	1	1360	19980826	GL879251	365 +/- 25	3.78 +/- 5	666 +/- 63
Nanticoke-Stelco outfall	16	1	1359	19980826	GL879252	235 +/- 16	3.27 +/- 5	436 +/- 55
Nanticoke-Ontario Hydro outfall	16	1	1362	19981029	GL879351	17 +/- 10	4.14 +/- 5	21 +/- 50
Nanticoke-Esso outfall	16	1	1365	19981029	GL879352	21 +/- 10	4.24 +/- 5	26 +/- 50
Nanticoke	16	1	1361	19981029	GL879356	17 +/- 10	4.58 +/- 5	12 +/- 50
Nanticoke Creek (mouth)	16	15	72	19981029	GL879357	245 +/- 24	5.80 +/- 5	305 +/- 57
Nanticoke	16	1	1360	19981029	GL879354	47 +/- 12	4.16 +/- 5	43 +/- 50
	16	1	1360	19981029	GL879355	50 +/- 10	2.84 +/- 5	47 +/- 51
Nanticoke-Stelco outfall	16	1	1359	19981029	GL879353	43 +/- 11	4.82 +/- 5	41 +/- 50
Nanticoke Creek (F-blank)	16	15	72	19981029	GL879358	1 +/- 10	-0.17 +/- 5	5 +/- 50
Nanticoke Creek (T-blank)	16	15	72	19981026	GL879359	1 +/- 10	-0.15 +/- 5	1 +/- 50
Nanticoke-Stelco (F-blank)	16	1	1359	19980826	GL879253	2 +/- 10	0.08 +/- 5	10 +/- 50
Port Dover								
Port Dover-WPCP outfall	16	1	1364	19980422	GL878698	62 +/- 6	0.61 +/- 0.29	35 +/- 22
Port Dover-lake stn.	16	1	1358	19980422	GL878699	46 +/- 3	0.03 +/- 0.32	25 +/- 21
	16	1	1358	19980422	GL878700	47 +/- 3	0.40 +/- 0.44	25 +/- 22
Port Dover-Harbour	16	17	62	19980422	GL878701	376 +/- 28	5.69 +/- 1.1	453 +/- 56

Station Description	Station			Date	Field No.	Aluminum	Chromium	Iron
Port Dover-Lynn River	16	15	70	19980422	GL878702	234 +/- 15	2.61 +/- 0.4	459 +/- 34
Port Dover-Lynn River	16	15	69	19980422	GL878704	110 +/- 6	3.85 +/- <1	380 +/- 34
Port Dover-Black Creek	16	15	68	19980422	GL878703	720 +/- 50	2.83 +/- 1.1	616 +/- 60
Port Dover-WPCP outfall	16	1	1364	19980825	GL879223	193 +/- 17	0.37 +/- 5	359 +/- 55
Port Dover-lake stn.	16	1	1358	19980825	GL879229	62 +/- 11	0.28 +/- 5	115 +/- 51
Port Dover-Harbour	16	17	62	19980825	GL879224	271 +/- 17	4.99 +/- 5	518 +/- 61
Port Dover-Lynn River	16	15	70	19980825	GL879225	95 +/- 11	4.84 +/- 5	225 +/- 52
Port Dover-Lynn River	16	15	69	19980825	GL879226	88 +/- 12	7.50 +/- 5	313 +/- 53
	16	15	69	19980825	GL879227	92 +/- 14	8.54 +/- 5.1	384 +/- 62
Port Dover-Black Creek	16	15	68	19980825	GL879228	109 +/- 12	6.91 +/- 5	260 +/- 52
Port Dover-WPCP outfall	16	1	1364	19981028	GL879343	96 +/- 11	6.59 +/- 5	185 +/- 51
	16	1	1364	19981028	GL879344	93 +/- 24	4.55 +/- 5.3	173 +/- 64
Port Dover-lake stn.	16	1	1358	19981028	GL879345	34 +/- 10	7.54 +/- 5	73 +/- 50
Port Dover-Harbour	16	17	62	19981028	GL879349	66 +/- 18	3.83 +/- 5.1	132 +/- 57
Port Dover-Lynn River	16	15	70	19981028	GL879346	44 +/- 11	1160.00 +/- 350	-158 +/- 240
Port Dover-Lynn River	16	15	69	19981028	GL879347	71 +/- 12	14.30 +/- 5.1	283 +/- 57
Port Dover-Black Creek	16	15	68	19981028	GL879348	98 +/- 12	12.40 +/- 5	183 +/- 51
Port Dover- (F-blank)	16	17	62	19981028	GL879350	0 +/- 10	0.00 +/- 5	0 +/- 50
Port Dover- (F-blank)	16	15	69	19980422	GL878705	1 +/- <1	-0.25 +/- <1	0 +/- 21
Port Dover- (F-blank)	16	1	1358	19980825	GL879230	5 +/- 10	-0.01 +/- 5	44 +/- 50
Port Bruce								
Port Bruce- lake stn.	16	1	1354	19980428	GL878721	83 +/- 6	1.06 +/- 0.43	124 +/- 30
Port Bruce-embayment	16	1	1352	19980428	GL878722	260 +/- 15	0.82 +/- 0.21	435 +/- 34
	16	1	1352	19980428	GL878723	280 +/- 20	2.01 +/- 0.58	468 +/- 44
Port Bruce-outside harbour	16	1	1353	19980428	GL878724	179 +/- 12	1.35 +/- 0.35	305 +/- 37
Port Bruce-Harbour	16	17	56	19980428	GL878725	213 +/- 33	1.15 +/- 0.22	327 +/- 55
Port Bruce-Harbour	16	17	55	19980428	GL878726	204 +/- 13	0.83 +/- 0.21	256 +/- 31
Port Bruce-Catfish Creek	16	15	65	19980428	GL878727	227 +/- 20	0.47 +/- 0.21	258 +/- 32
Port Bruce-lake stn.	16	1	1354	19980813	GL879107	52 +/- 10	0.23 +/- 5	84 +/- 51
Port Bruce-embayment	16	1	1352	19980813	GL879108	207 +/- 40	1.14 +/- 5	374 +/- 110
Port Bruce-outside harbour	16	1	1353	19980813	GL879109	217 +/- 17	0.55 +/- 5	390 +/- 54
Port Bruce-Harbour	16	17	56	19980813	GL879110	829 +/- 37	1.92 +/- 5	1622 +/- 96
	16	17	56	19980813	GL879111	815 +/- 41	1.09 +/- 5	1569 +/- 110
Port Bruce-Harbour	16	17	55	19980813	GL879112	433 +/- 37	1.28 +/- 5	674 +/- 90
Port Bruce-Catfish Creek	16	15	65	19980813	GL879113	567 +/- 27	2.61 +/- 5	847 +/- 65
Port Bruce-lake stn.	16	1	1354	19981022	GL879328	135 +/- 17	6.82 +/- 5.1	206 +/- 52
Port Bruce-embayment	16	1	1352	19981022	GL879329	251 +/- 17	8.35 +/- 5	436 +/- 56
	16	1	1352	19981022	GL879330	260 +/- 20	7.79 +/- 5	460 +/- 53
Port Bruce-outside harbour	16	1	1353	19981022	GL879331	197 +/- 16	7.31 +/- 5	321 +/- 53
Port Bruce-Harbour	16	17	56	19981022	GL879332	211 +/- 29	8.61 +/- 5.2	341 +/- 65
Port Bruce-Harbour	16	17	55	19981022	GL879333	228 +/- 18	13.20 +/- 5.1	357 +/- 54
Port Bruce-Catfish Creek	16	15	65	19981022	GL879334	260 +/- 17	14.80 +/- 5.2	370 +/- 56
Port Bruce- (F-blank)	16	15	65	19980428	GL878728	1 +/- 0	-0.07 +/- 0.22	-4 +/- 20
Port Bruce- (F-blank)	16	15	65	19980813	GL879114	1 +/- 10	0.01 +/- 5	9 +/- 52
Port Bruce- (T-blank)	16	15	65	19980810	GL879115	0 +/- 10	0.01 +/- 5	4 +/- 51
Port Bruce- (F-blank)	16	15	65	19981022	GL879335	1 +/- 10	0.34 +/- 5	7 +/- 50
Port Bruce- (T-blank)	16	15	65	19981019	GL879336	0 +/- 10	0.09 +/- 5	5 +/- 51
Port Burwell								
Port Burwell-lake stn.	16	1	1350	19980429	GL878729	147 +/- 11	1.18 +/- 0.32	216 +/- 28
Port Burwell-Harbour	16	17	53	19980429	GL878730	135 +/- 13	0.43 +/- 0.26	196 +/- 33
	16	17	53	19980429	GL878731	132 +/- 13	0.66 +/- 0.31	192 +/- 38
Port Burwell-Harbour	16	17	52	19980429	GL878732	120 +/- 10	0.52 +/- 0.23	175 +/- 29
Port Burwell-Harbour embayment	16	17	51	19980429	GL878733	91 +/- 5	5.37 +/- 1.1	114 +/- 21

Station Description	Station			Date	Field No.	Aluminum	Chromium	Iron
Port Burwell-Harbour	16	17	50	19980429	GL878734	183 +/- 10	10.30 +/- 1.3	233 +/- 27
Big Otter Creek (upstream of bridge)	16	15	60	19980429	GL878735	186 +/- 10	4.35 +/- 0.63	239 +/- 26
Port Burwell-lake stn.	16	1	1350	19980812	GL878786	65 +/- 11	2.44 +/- 5	118 +/- 50
Port Burwell-Harbour	16	17	53	19980812	GL878788	87 +/- 13	0.86 +/- 5	129 +/- 51
	16	17	53	19980812	GL878789	80 +/- 11	2.94 +/- 5	117 +/- 51
Port Burwell-Harbour	16	17	52	19980812	GL878787	117 +/- 13	0.82 +/- 5	190 +/- 51
Port Burwell-Harbour embayment	16	17	51	19980812	GL878790	156 +/- 13	2.55 +/- 5	227 +/- 52
Port Burwell-Harbour	16	17	50	19980812	GL878791	232 +/- 16	6.25 +/- 5	337 +/- 57
Big Otter Creek (upstream of bridge)	16	15	60	19980812	GL878792	247 +/- 22	5.55 +/- 5.1	331 +/- 65
Port Burwell-reference stn.	16	1	1350	19981117	GL879360	493 +/- 27	5.44 +/- 5	1000 +/- 71
Port Burwell-Harbour	16	17	53	19981117	GL879361	535 +/- 29	6.51 +/- 5	1140 +/- 76
Port Burwell-Harbour	16	17	52	19981117	GL879362	507 +/- 27	6.80 +/- 5	1050 +/- 73
Port Burwell-Harbour embayment	16	17	51	19981117	GL879363	601 +/- 34	6.80 +/- 5	1270 +/- 84
	16	17	51	19981117	GL879364	638 +/- 35	6.39 +/- 5	1340 +/- 84
Port Burwell-Harbour	16	17	50	19981117	GL879365	82 +/- 13	8.45 +/- 5.1	173 +/- 51
Big Otter Creek (upstream of bridge)	16	15	60	19981117	GL879366	73 +/- 12	8.43 +/- 5	177 +/- 52
Big Otter Creek (F-blank)	16	15	60	19980429	GL878736	1 +/- 1	0.33 +/- 0.41	3 +/- 20
Big Otter Creek (F-blank)	16	15	60	19980812	GL878793	1 +/- 10	0.10 +/- 5.1	4 +/- 51
Big Otter Creek (F-blank)	16	15	60	19981117	GL879367	0 +/- 10	0.57 +/- 5	9 +/- 50
Big Otter Creek (T-blank)	16	15	60	19981112	GL879368	1 +/- 10	0.53 +/- 5.1	9 +/- 51

Port Stanley

Station Description	Station			Date	Field No.	Aluminum	Chromium	Iron
Port Stanley-lake stn.	16	1	1356	19980428	GL878719	59 +/- 5	0.24 +/- 0.23	45 +/- 24
Port Stanley-embayment	16	1	1355	19980428	GL878720	148 +/- 9	0.35 +/- 0.21	243 +/- 26
Port Stanley-Harbour	16	17	58	19980428	GL878717	188 +/- 23	0.74 +/- 0.29	243 +/- 39
	16	17	58	19980428	GL878718	182 +/- 13	0.40 +/- 0.23	249 +/- 38
Harbour at storm sewer	16	17	57	19980428	GL878716	206 +/- 12	0.56 +/- 0.22	259 +/- 27
Port Stanley-Kettle Creek	16	15	67	19980428	GL878715	322 +/- 22	0.67 +/- 0.22	382 +/- 54
Kettle Creek (upstream)	16	15	66	19980428	GL878714	388 +/- 22	0.95 +/- 0.24	476 +/- 53
Port Stanley- lake stn.	16	1	1356	19980811	GL878761	41 +/- 11	2.69 +/- 5	69 +/- 51
Port Stanley-embayment	16	1	1355	19980811	GL878762	68 +/- 11	0.38 +/- 5	105 +/- 50
Port Stanley-Harbour	16	17	58	19980811	GL878763	314 +/- 21	2.33 +/- 5	388 +/- 59
Harbour at storm sewer	16	17	57	19980811	GL878764	286 +/- 21	4.01 +/- 5.2	343 +/- 96
Port Stanley-Kettle Creek	16	15	67	19980811	GL878765	544 +/- 32	1.23 +/- 5	603 +/- 68
Kettle Creek (upstream)	16	15	66	19980811	GL878766	718 +/- 44	2.80 +/- 5	840 +/- 80
	16	15	66	19980811	GL878767	662 +/- 44	4.76 +/- 5	733 +/- 80
Port Stanley-lake stn.	16	1	1356	19981019	GL879320	73 +/- 11	6.45 +/- 5	116 +/- 52
Port Stanley-embayment	16	1	1355	19981019	GL879321	420 +/- 50	8.03 +/- 5.1	926 +/- 130
Port Stanley-Harbour	16	17	58	19981019	GL879322	422 27	8.06 5	919 72
Harbour at storm sewer	16	17	57	19981019	GL879323	465 +/- 29	7.63 +/- 5	976 +/- 78
	16	17	57	19981019	GL879324	465 31	6.95 5	951 89
Port Stanley-Kettle Creek	16	15	67	19981019	GL879325	344 +/- 44	7.[illegible]8 +/- 5.1	633 +/- 110
Kettle Creek (upstream)	16	15	66	19981019	GL879326	292 +/- 20	10.50 +/- 5.1	409 +/- 57
Port Stanley- (F-blank)	16	15	66	19980811	GL878768	1 +/- 10	0.05 +/- 5	6 +/- 50
Port Stanley- (F-blank)	16	15	66	19981019	GL879327	0 +/- 10	0.18 +/- 5	3 +/- 50

Thames River

Station Description	Station			Date	Field No.	Aluminum	Chromium	Iron
Lake St. Clair-North of Thames River	4	1	230	19980423	GL878708	181 +/- 16	0.63 +/- 0.22	172 +/- 30
Lake St. Clair-West of Thames River	4	1	231	19980423	GL878707	582 +/- 77	2.55 +/- 1	533 +/- 96
Lake St. Clair- NW of river mouth	4	1	232	19980423	GL878706	290 +/- 33	3.32 +/- 1.1	199 +/- 29
Thames River (mouth)	4	15	16	19980423	GL878710	742 +/- 48	1.19 +/- 0.94	650 +/- 39
Thames River-mouth	4	15	16	19980423	GL878709	703 +/- 68	1.28 +/- 0.28	642 +/- 64
Thames River (upstream)	4	15	15	19980423	GL878711	710 +/- 61	1.94 +/- 0.47	623 +/- 59
Lake St. Clair-North of Thames River	4	1	230	19980805	GL878739	72 +/- 13	0.02 +/- 5	61 +/- 50
Lake St. Clair-West of Thames River	4	1	231	19980805	GL878738	161 +/- 15	0.10 +/- 5	217 +/- 52
Lake St. Clair-Thames River	4	1	232	19980805	GL878737	75 +/- 11	-0.11 +/- 5	75 +/- 50

Station Description	Station			Date	Field No.	Aluminum	Chromium	Iron
Thames River-mouth	4	15	16	19980805	GL878741	217 +/- 15	0.08 +/- 5	297 +/- 52
Thames River-mouth	4	15	16	19980805	GL878740	223 +/- 19	0.17 +/- 5	306 +/- 55
Thames River (upstream)	4	15	15	19980805	GL878742	198 +/- 18	0.13 +/- 5	276 +/- 53
Lake St. Clair-North of Thames River	4	1	230	19981014	GL879314	299 +/- 24	6.04 +/- 5	428 +/- 60
Lake St. Clair-West of Thames River	4	1	231	19981014	GL879312	148 +/- 16	4.72 +/- 5	183 +/- 51
Lake St. Clair-Thames River	4	1	232	19981014	GL879313	259 +/- 19	5.27 +/- 5	421 +/- 55
Thames River-mouth	4	15	16	19981014	GL879315	358 +/- 31	6.87 +/- 5	512 +/- 60
Thames River-mouth	4	15	16	19981014	GL879316	378 +/- 22	5.98 +/- 5	528 +/- 57
Thames River (upstream)	4	15	15	19981014	GL879317	298 +/- 24	7.68 +/- 5.1	393 +/- 60
Thames River (T-blank)	4	15	15	19980423	GL878706	1 +/-	0.09 +/-	-3 +/-
Thames River (F-blank)	4	15	15	19980423	GL878712	2 +/- 1	0.09 +/- 0.22	<1 +/- 21
Thames River (F-blank)	4	15	15	19980805	GL878743	2 +/- 10	-0.11 +/- 5	11 +/- 50
Thames River (T-blank)	4	15	15	19980804	GL878744	0 +/- 10	-0.20 +/- 5	3 +/- 50
Thames River (F-blank)	4	15	15	19981014	GL879318	1 +/- 10	0.02 +/- 5	2 +/- 50
Thames River (T-blank)	4	15	15	19981013	GL879319	1 +/- 10	0.07 +/- 5	2 +/- 50

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